RETURN TO 103 BROAD ST.
GENERAL
SUPERINTENDENT'S
OFFICE,
ELECTRIC DEPT.
NEWARK, N. J.

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## A TURBINE STATION FOR GENERAL POWER SUPPLY

CHICAGO is fortunate in having at the head of its electric companies men who take a broad view of the needs of the city, and a long look into the future requirements. Before the ordinary layman could see the occasion for such a provision the Commonwealth Electric Co. had made plans for a tremendous capacity in the Fiske Street station to supply the city itself.

More recently, the North Shore Electric Co., study-

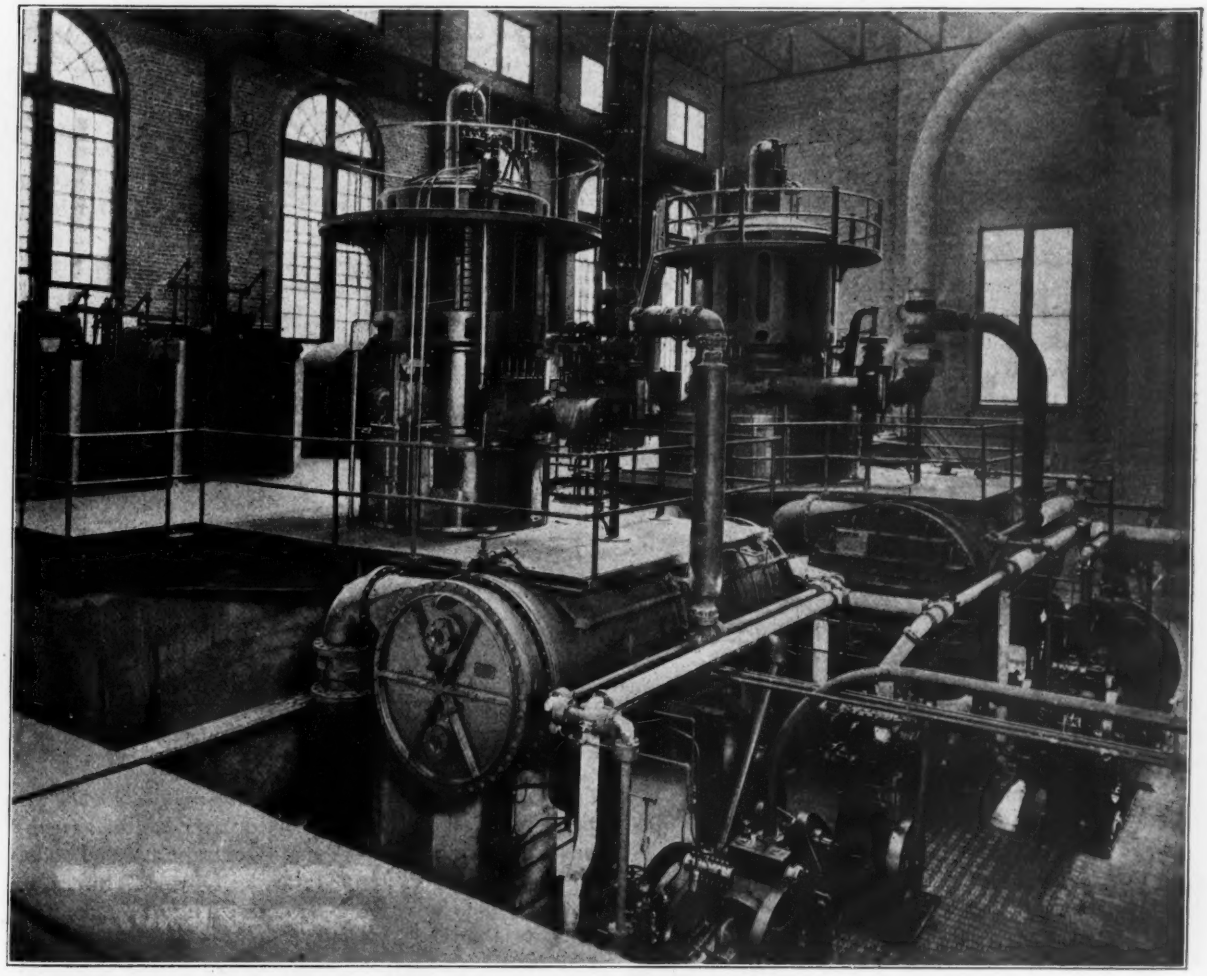

FIG. I. TURBINE UNITS AND CONDENSING EQUIPMENT AT BLUE ISLAND

ing the present needs and the future growth of the suburban towns, has started a plan whereby adequate provision will be made for the supply of current for lighting, power and street railways in the surrounding villages. The old provision consisted of separate installations,—several of which were good at the time they were put in, but are now out of date,—one or none for each village. Part of these were private plants well handled and serving a small territory well for the immediate present. Others were municipally

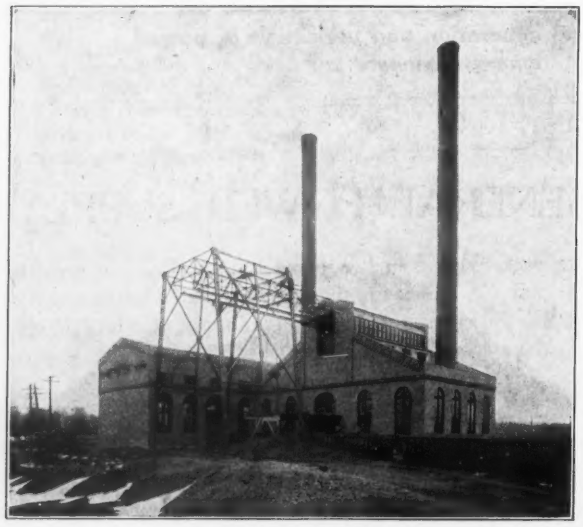

FIG. 2. BLUE ISLAND STATION

owned plants, more or less badly managed, and giving an apology for service to comparatively few.

Knowing the success of the Commonwealth company in supplying the outlying parts of the city from 1 central station, the moving spirits of the North Shore Electric Co. devised the plan of supplying the outer circle of towns from similar central stations which by a working agreement should draw in case of emergency on the resources of the Fiske Street station.

This has the double advantage of giving supply from large stations for the small villages, reducing the cost by use of modern apparatus and methods and, because of the emergency reserve at Fiske Street, eliminating the necessity for a great provision of reserve machinery in the outer central stations.

As locations for 4 central stations in this plan, Evanston, Maywood, Blue Island and Waukegan have been chosen. Evanston has been running for some time, Maywood has been established for a matter of 2 years, Blue Island has been in service somewhat less than a year, and Waukegan is on the point of completion. The rapid growth of the city and its suburbs and the rapid increase of demand for current has, however, more than kept pace with the provision for supply, so that the stations now in commission are having to carry their limit capacity and the older stations are still having to do service. The largest of these stations is that of Blue Island, which is the subject of the present article.

### Blue Island

Blue Island is really an island, spite of the fact that its surroundings do not at first sight seem to indicate the fact, and that the only water anywhere in sight is the Little Calumet River. On the east, only 10 miles distant, is Lake Michigan, on the north the Chicago Drainage Canal, some 16 miles away, on the west the Desplaines River about 30 miles off, and to the south, 300 miles away, the Ohio River; nevertheless it is "a small body of land surrounded by water." Some time in the distant past probably the surrounding bodies of water came nearer to the island. At the time of the writer's visit the greatest depth was 2.5 ft. in the Little Calumet, although during the spring the rise of the river is such that there is 10 ft. of water.

The suburb iself hardly seems to require a capacity of 3,000 kilowatts in a central station, but located within transmitting distance are Chicago Heights, Harvey and Morgan Park, as well as other smaller villages, and the Chicago & Southern Traction Co. takes power from the station to supply its lines as far south as Kankakee. This gives a demand which brings the station up to the limit of its capacity and the installation of an additional 3500-kw. turbine unit is now under consideration.

In order to supply current for lighting, power and railway work, it is necessary to furnish both 25-cycle and 60-cycle current, and at voltages of 2300 for local

FIG. 3. ONE SIDE OF THE BOILER ROOM

distribution, 4,000 for intermediate points, 10,000 for more distant points, and 33,000 for the railroad transmission. The generators supply current at 9,000 volts, which is stepped up and down by transformers as required for the various services. The generator frequency is 25 cycles, and for lighting service the current is run through frequency changers and delivered at 60 cycles. The ultimate plan of the station allows

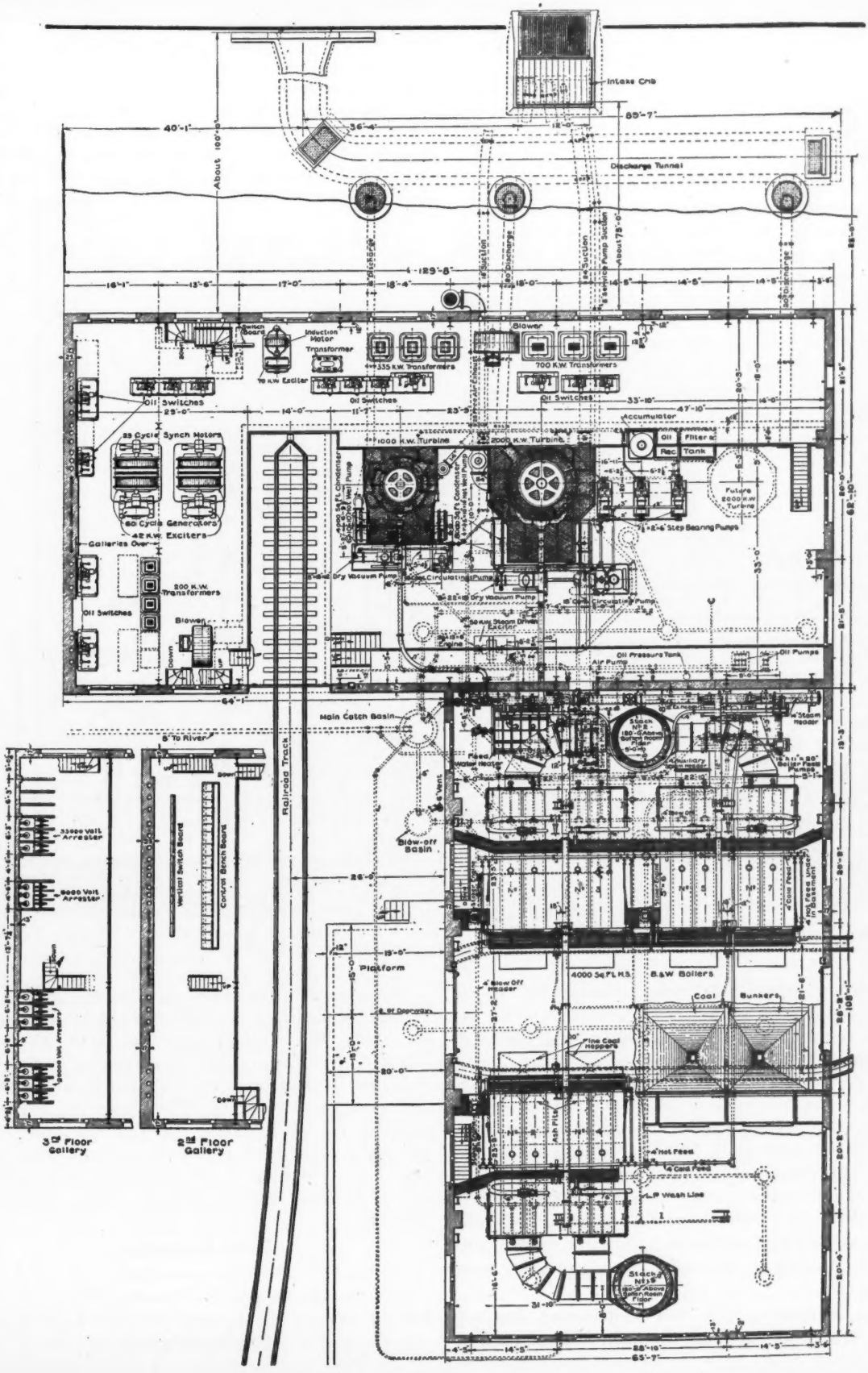


FIG. 5. PLAN OF BUILDINGS AND ARRANGEMENT OF MACHINERY AT BLUE ISLAND

for twice the capacity that can be installed in the present building, or about 7,000 kilowatts. There are at present installed a 1,000 and a 2,000 kilowatt turbine unit with space for a third large unit. The appearance of the turbine room is shown in Fig. 1 and the arrangement of machinery and of the station in the drawing, Fig. 5.

### Building

Boiler house and generator house are in separate structures with fire wall between. In the boiler house basement is space for the foundations, the pump and feed water piping, oil filters, ash handling apparatus, lavatories and storage for extra piping and boiler repair parts.

The boiler room proper contains batteries of boilers, feed-water heater, pumps, traps and boiler piping, and above is located a coal pocket of 400 tons capacity. To supply this pocket a car of coal is backed under the trestle; a clam shell bucket lifts the coal to the height of the door and is carried by the traveling car which controls it through the door over the coal pocket, where it drops its load.

From the coal pocket the coal drops through chutes to the stoker hoppers and, after combustion the ash is dropped to ash hoppers underneath, from which cars on a narrow gage track take it for filling in the low spots about the plant. On account of the rise of the river in the spring, it has been found necessary to make the river side of the building water tight and to put a dike along above the high water mark to prevent the flooding of the condenser pit and boiler room basement.

The generator room and switchboard compartments are in one building, the main floor of the generator room being on the level with the boiler room floor, and condenser apparatus installed in a pit on a level with the floor of the boiler room basement. The high-tension busbars and minor switching apparatus are installed beneath the floor of the generator room and the high-tension switches are installed in compartments in the generator room near the transformer.

Control boards are located on a gallery at 1 end of the generator room and on a second gallery are located the lightning arresters and the take-out openings of the high-tension transmission lines. The buildings are of red brick with steel framework, and with steel roof trusses on which tile roof is laid with tar and sand for a covering. The floors are reinforced concrete, laid on I beams. Busbars and switch compartments are of brick with iron doors and ventilating openings. The floor of the condenser pit is vitrified tile made water tight so that it can be flooded for washing.

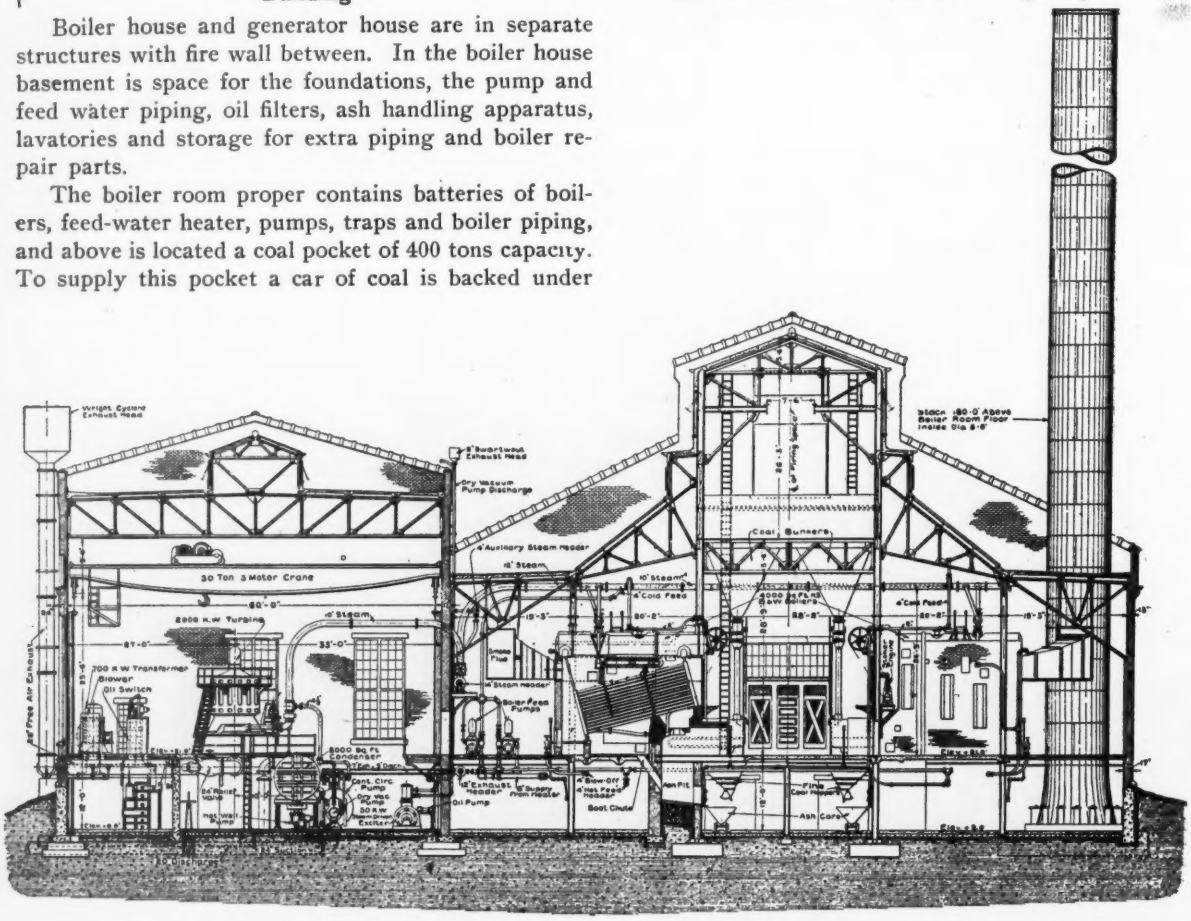


FIG. 4. SECTION OF STATION AND ELEVATION OF PIPING

### Boiler Equipment

In the boiler room are installed 6 Babcock & Wilcox water-tube boilers, 2 in battery, fitted with Babcock & Wilcox chain grate stokers. Each of these

*(Continued on p. 47)*

# SOME METHODS OF BELTING AT ANY ANGLE

By S. J. Kelley

THERE is hardly any angle at which a belt cannot be run and do service nearly as well as straight belting.

Herewith are a few illustrations of belts at different angles. In Fig. 1, a quarter turn belt drive, D is the driver, revolving in the direction of the arrow, and F is the follower, the point at which the belt is delivered from pulley D lies in the middle plane of pulley F in the line b b. The point at which the belt is delivered from pulley F lies in the center of plane of pulley D or a line a a. The pulleys cannot

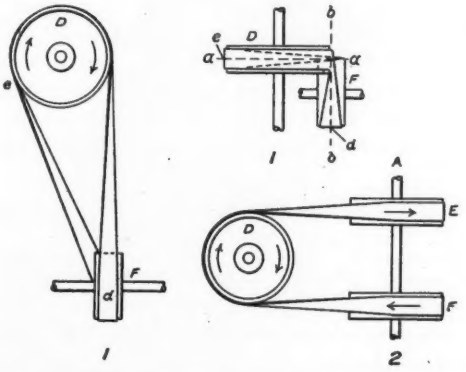


FIG. 1. ARRANGEMENT OF A QUARTER TURN BELT DRIVE

FIG. 2. REVERSIBLE CONNECTION FOR SHAFTS AT RIGHT ANGLES

run backwards, as d, the point of delivery of F, is not in the middle plane a a, and e is not in the middle of b b.

Figure 2 shows a connection for 2 shafts at right angles, which, in general is preferred to a quarter turn belt. D is the driver; the belt passes around the loose pulleys E and back again around a loose pulley on the drive shaft back of D and then goes around F, which is fast on shaft A, and finally around D.

Since the loose pulleys revolve in directions opposite to those of the shafts, the hubs should be long. The 2 pulleys must be the same size and either F or D can be the driver, and run in either direction.

In Fig. 3 we have guide pulleys, sometimes used to lengthen belts between 2 shafts that are too close to be direct connected, or where it may not be possible to get the 2 pulleys in the same plane. The diameter of guide pulleys must equal the distance between D and F. With guide pulleys arranged as shown the belt can be run in either direction.

It is more convenient, at times, to place both pulleys on one shaft, in which case their axis will be on line O O. $G^1$ would be in line C K and G in line A B. Then the belt will be delivered from D into the middle plane of $G^1$ and from G into the middle plane of F. The belt will run in only 1 direction.

Figure 4 shows a way to connect 2 horizontal shafts at an angle with one another, and which can be used where a quarter turn will not work successfully. The guide pulleys run in the same direction, which is a great convenience, as they can be mounted on the same shaft with bearings on each end, and the belt will run in any direction that is handy.

## COLORED PIPING FOR POWER HOUSES

At the recent meeting of the American Society of Mechanical Engineers, William H. Bryan advocated the adoption of a uniform system of colors to designate the different kinds of piping in a plant.

Such a method has been used by the Bureau of Steam Engineering of the Navy, the Internal Revenue Department, the New York Edison Co., the Long Island R. R. Co. and some special plants. Nothing of uniformity exists however, and adoption of some

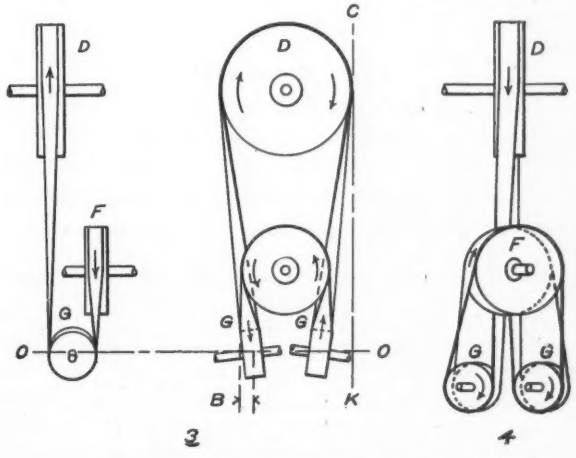


FIG. 3. CONNECTION FOR CLOSE PARALLEL SHAFTS

FIG. 4. BELT ARRANGEMENT FOR SHAFTS AT ANY ANGLE

standard system would be helpful as enabling anyone who was familiar with it to tell what the pipes in any plant were for. This with arrows to show the direction of flow would much simplify the work of the engineer. In the paper, the different kinds of piping to be marked were pointed out and suggestion made for a committee to consider the matter and report a system of colors.

Manufacturing gas from sawdust and other mill refuse is a process recently invented by J. R. Coutts, whose ideas are now being put into commercial form by the International Heating & Lighting Co., of Cleveland, Ohio.

# BELTS AND BUCKETS FOR HANDLING COAL AND ASH

ONE of the subjects fully treated at the Detroit meeting of the American Society of Mechanical Engineers was the handling of materials by machinery. While the 4 papers presented cover all kinds of materials, the subject of coal and ash handling is fully treated, and the matter relating to this subject is here abstracted from all the papers.

Staunton B. Peck, vice president of The Link Belt Co., of Chicago, gave a general discussion of the subject and of the various types. The simplest of these are the

TABLE I CAPACITIES OF FLIGHT CONVEYORS, TONS OF 2,000 LB. AN HOUR AT 100 FT. A MIN.

| SIZE OF FLIGHT | HORIZONTAL | | | | INCLINED | | |
|---|---|---|---|---|---|---|---|
| | Spaced | | | lb. per flight | 10 deg. 24 in. | 20 deg. 24 in. | 30 deg. 24 in. |
| | 16 in. | 18 in. | 24 in. | | | | |
| 4 by 10 | 33⅓ | 30 | 22½ | 15 | 18 | 14½ | 10½ |
| 4 by 12 | 42⅔ | 38 | 28½ | 19 | 24 | 18 | 13½ |
| 5 by 12 | 51⅓ | 46 | 34½ | 23 | 28½ | 22½ | 16½ |
| 5 by 15 | 69¼ | 62 | 46½ | 31 | 40½ | 31½ | 22½ |
| 6 by 18 | | 80 | 60 | 40 | 49½ | 40½ | 31½ |
| 8 by 18 | | 120 | 90 | 60 | 72 | 57 | 48 |
| 8 by 20 | | | 105 | 70 | 84 | 66½ | 56 |
| 8 by 24 | | | 135 | 90 | 120 | 96 | 72 |
| 10 by 24 | | | 172½ | 115 | 150 | 120 | 90 |

### Flight Conveyors

which pull or push the load in troughs. Their field of usefulness is limited on account of the rapid wear and the power consumed. The common working speeds are 100 to 200 ft. a minute and the capacities are shown in Table I.

TABLE II. CAPACITY OF BUCKET FLIGHT CONVEYOR TONS OF COAL AN HOUR AT 100 FT.

| BUCKET | SPACING | | | |
|---|---|---|---|---|
| Length and width in inches | 18 in. | 24 in. | 36 in. | 48 in. |
| 12 by 12 | 31.0 | 23.5 | 15.5 | 11.7 |
| 16 by 12 | 41.3 | 31.3 | 20.5 | 15.6 |
| 16 by 15 | 61.4 | 46.5 | 30.7 | 23.3 |
| 20 by 15 | 78.0 | 59.0 | 39.0 | 29.5 |
| 24 by 15 | 91.0 | 69.0 | 45.5 | 34.5 |
| 20 by 20 | 138.0 | | 69.0 | |
| 24 by 20 | 165.0 | | 82.5 | |
| 30 by 20 | 206.0 | | 103.0 | |
| 36 by 20 | 248.0 | | 124.0 | |
| 30 by 24 | | 220.0 | 145.0 | 110.0 |
| 36 by 24 | | 262.0 | 173.0 | 131.0 |
| 48 by 24 | | 350.0 | 232.0 | 175.0 |

Power required to handle anthracite coal is found as follows: Multiply the tons per hour by the length of the conveyer, center to center in feet and by a constant A given below; call this product (1). Multiply the weight in pounds of chain and flights in both runs by the speed in feet per minute and by a constant B from the table below; call this product (2). Subtract (2) from (1) and divide the difference by 1,000 and the result will be the horsepower required.*

| Inclination, deg. | 0 | 5 | 10 | 20 | 30 | 40 |
|---|---|---|---|---|---|---|
| A | 0.343 | 0.42 | 0.50 | 0.66 | 0.79 | 0.90 |
| B | 0.01 | 0.01 | 0.01 | 0.009 | 0.009 | 0.008 |

In a modification, the flights have bucket form so that at an upward turn the coal falls into the buckets and may be carried vertically, to be turned into a horizontal trough when desired. The capacities and power required are given in Tables II and III.

### Spiral Conveyors

These are compact and well adapted for enclosed work, but like scraper conveyors are costly to maintain when handling gritty material. They consist of a shaft with a steel or cast-iron ribbon winding around it in screw form and push the material forward in a trough. One hundred feet is about the limit for a single length of spiral conveyor and the capacities in cubic feet conveyed per hour at 100 revolutions a minute are as follows: For a diameter 6 in., 260; for 8 in., 660; for 10 in., 1000; for 12 in., 1660; for 14 in., 2500; for 16 in., 3660; for 18 in., 5000. The horsepower required is found by multiplying the capacity in pounds per minute by the length of the conveyor in feet and by a constant and dividing by 33,000. For coal the constant is 0.67 and for ash it is 1.

TABLE III. HORSEPOWER OF ELEVATOR CONVEYORS

| SIZE OF BUCKET | 12 by 12 in. | | | 24 by 15 in. | | | 36 by 20 in. | | 48 by 24 in. | |
|---|---|---|---|---|---|---|---|---|---|---|
| Spacing | 18 in. | 24 in. | 36 in. | 18 in. | 24 in. | 36 in. | 18 in. | 24 in | 36 in. | 48in. |
| H.p. for each 10 ft. vert. lift | 0.46 | 0.35 | 0.23 | 1.35 | 1.0 | 0.67 | 3.8 | 1.9 | 3.5 | 2.7 |
| H.p. for each 100 ft. hor. empty | 1.2 | 1.1 | 0.9 | 1.7 | 1.5 | 1.3 | 2.4 | 1.6 | | |
| Do. handling anthracite | 2.5 | 2.1 | 1.5 | 5.3 | 4.3 | 3.1 | 12.4 | 6.6 | | |
| Do handling bituminous | 3.2 | 2.6 | 1.9 | 7.4 | 5.8 | 4.2 | 18 | 9.4 | | |

Add 5 per cent for each turn.

### Bucket Conveyors

From the bucket fixed to the chain which acts partly as a scraper and partly as elevator, is developed the overlapping bucket carrier arranged to fill without spilling and to discharge at any point of the travel of the conveyor.

In the most recent form of carrier, correct action is obtained by suspending the bucket from extensions from the inner chain links beyond the points of articulation, as in Fig. 3. By this means the buckets travel through a longer path than do the chains from which they are suspended when passing around the wheel

*In an equation form,

$$\text{Hp. equals } \frac{ATL-BWS}{1000}$$

Where T equals net tons per hour, L equals length center to center, ft., W equals weight, lb., of chain and flights, both runs, S equals speed, ft. per min.

in starting to ascend, and thus automatically unlap themselves. Conveyors of this character are usually run at 30 to 50 ft. a minute, and where equipped with self-oiling rollers of 6 to 8 in. diameter, require but little power for their operation. Table IV shows the capacity and power for various conveyors of this type.

Conveyors which carry their load vertically are known as elevators and in the most elementary form consist of 1 or 2 endless strands of link belts to which are attached at intervals buckets or cups. The lower wheels are carried in a boot into which the material to be elevated is delivered, and in passing around these wheels the buckets scoop up their load, throwing it out upon a chute by centrifugal force as they pass

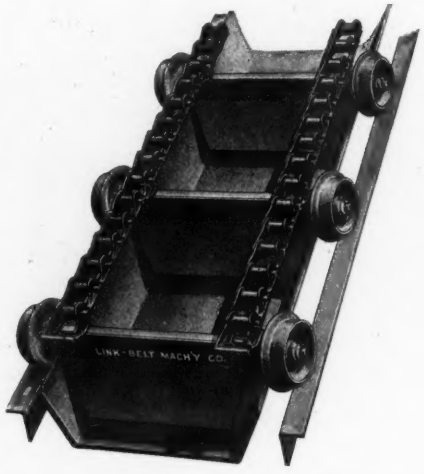


FIG. I. ROLLER FLIGHT CONVEYORS

around the upper or head wheel. This form has the same limitations as the scraper type of conveyor.

The accepted type of modern power house, with large storage bins above the boiler, from which coal is drawn by hoppers and chutes to mechanical stokers, is made possible by the conveyor which receives the coal from cars, boats or wagons outside the building, elevates and distributes it in the overhead bin, and by means of the returning run in the basement the ash is drawn from the hoppers beneath the boilers and elevated to overhead boxes whence it may be drawn to boats or cars. In such boiler rooms no coal or ash is visible, and the same cleanliness may be maintained as in the engine room.

For this purpose the pivoted bucket carrier to which we have just referred, has for a number of years been regarded as standard, usually handling both coal and ash in the same conveyor; but some power houses handle the ash by a second carrier. The cost of handling by this means is reduced to a small amount.

Taking as an illustration a light and power plant of moderate size in New Hampshire where 1 of these carriers had been in use 4 years with no serious interruption: the annual consumption was 18,000 tons of coal per year, elevated 52 ft. and carried horizontally 110 ft. The average operation was 60 hours a week, 1 man looking after the carrier in connection with his other duties. The cost of repairs averages $120 a year, or 0.06 cent a ton handled, with a cost for power and attendance of 3 cents a ton, making a total of 3.06 cents per ton. These unit costs are high because the coal is handled at a rate very much below the capacity of the machine, and no credit in these figures is given to the tonnage of ash handled.

The street railway power house referred to in Table IV was equipped with duplicate carriers and consumed 15,000 tons of coal a month, the carriers operating about 65 hours a week, with a cost for repairs of but 0.1 cent a ton; and the machines showed scarcely any wear. The cost for power, supplies and attendance was 1.1 cents a ton.

A carrier equipped with 24 by 24-in. buckets at the Union Stock Yards, Chicago, with a vertical lift of 58 ft. and a horizontal run of 138 ft. has been in continuous operation since 1903, handling an average of 2500 tons of coal a week with no expenditure whatever for repairs, and is still in such excellent condition that it is probable no repairs will be required for some 5 years.

### Coal Storage Conveyors

For the storage of anthracite coal a different type of system is used, called the Dodge. In this the conveyor is so arranged that it distributes the coal in conical piles, the arrangement being different in each plant to meet the local conditions. This, however, has little to do with the power plant itself but is of importance as enabling the coal companies to store large quantities in comparatively small space and at small expense, so that the supply is made continuous without reference to the capacity or production of the mines.

For handling bituminous coal, some form of belt conveyor or clam shell bucket running on an overhead crane is usually adopted. For plants situated on the water front, the Atlantic states often use a form of unloader for vessels consisting of a tower with horizontal arm on which travels a clam shell bucket; this bucket is raised and lowered by a winding drum, and after grabbing its load of coal is lifted, pulled into the base of the tower, and dumped into a chute which usually delivers the coal to cars. The bucket may, however, be carried inland from the water front and dump its load into a storage yard.

### Belt Conveyors

These are almost universally carried by rollers spaced on the carrying run from 2.5 to 5 ft. apart, and at intervals usually twice as great or more on the idle run. The earliest belts were perfectly flat, supported by plain cylindrical rollers. Later types were made with troughing rollers in order to give a larger carrying capacity. It seemed that on acocunt of the greater speed of the outer ends of the troughed rollers, there would be a certain slip between the roller and the belt, but observation has shown that this is not sufficient to cause injury, and with the best modern practice for

large capacities a 4-roll idler is used, having the side rollers inclined from 35 to 40 degrees, while for smaller belts and modern capacities the old concave roller, which troughs the belt but slightly, is used, as it gives the greatest belt durability.

### Belting

Belts themselves are of canvas duck, woven solid, or having a number of plies from 3 to 8, stitched or

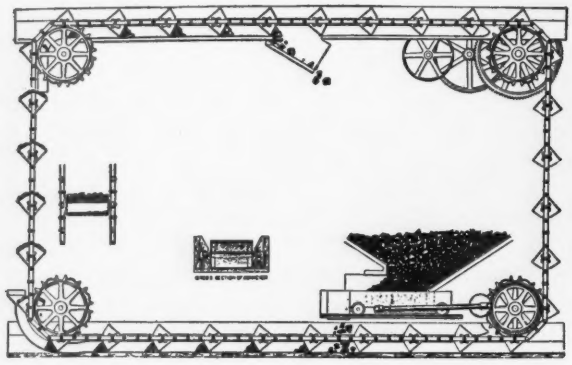

FIG. 2. BUCKET FORM OF FLIGHT CONVEYOR

cemented together with a composition of rubber, and known as rubber belt. Canvas belts are plain duck or treated with some preservative and for many kinds of service meet every requirement. For heavy duty where the canvas and fabric must be protected as perfectly as possible from moisture and cutting, rubber belts are preferred, and are usually made with a cushion of from 1/16 to ¼ inch more or less of pure rubber on the carrying side, which protects the fabric until this cushion is worn away.

Some belts have been used having fewer plies of canvas and a heavier cushion of rubber in the center where the belt is to receive and carry its heaviest load. Others have the fabric made thinner in points where it is intended the belt should be thin to form a trough, but experience seems to show that the greatest durability is attained by avoiding a localized banding.

The belt conveyor has a wide field of usefulness. It is simple, smooth and noiseless in operation, and may be run at a speed of 300 to 800 ft. a minute, with consequent large conveying capacity. On account of cost of belt and the large number of rollers required, the initial cost is greater than would be supposed, and not much less than for the bucket types of conveyor.

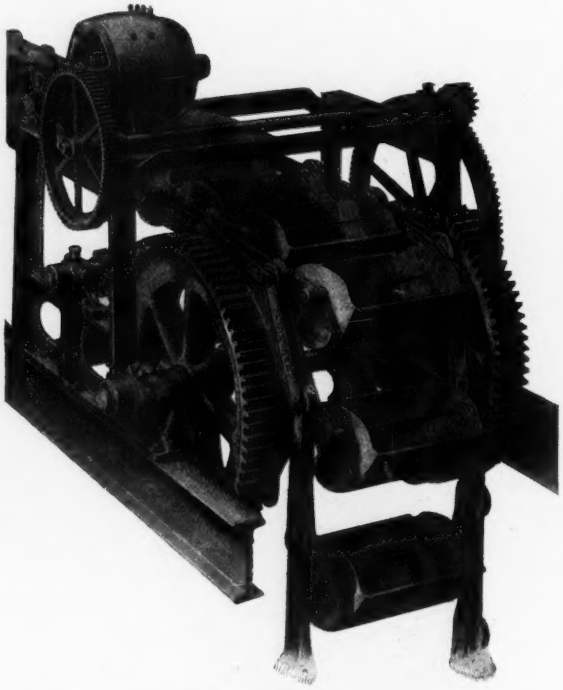

FIG. 3. PIVOTED OVERLAPPING BUCKET CONVEYOR

The most serious objection to belt conveyors is lack of durability of the belts, their average life probably being 2 to 3 years.

A futher objection is the difficulty of delivering at intermediate points, which is accomplished by a rather large and slow moving discharger.

In addition to the matter by Mr. Peck, 2 other papers were presented on the belt conveyor, one by C. Kemble Baldwin, of Chicago, the other by Edwin J. Haddock, of Columbus, Ohio. Mr. Baldwin's paper referred largely to the Robbins belt conveyor, and spoke of the improvements made by Mr. Thomas Robbins, Jr., in the quality of rubber belts. By these experiments belts which had formerly been destroyed in

TABLE IV. CAPACITY AND POWER FOR PIVOTED BUCKET CARRIERS

| Power House | Path | Speed per minute feet | H.P. REQUIRED RUNNING | | Tons per hour |
|---|---|---|---|---|---|
| | | | Light | Loaded | |
| A street railway | Horizontally 200 ft. vertically 110 ft. then horizontally 180 ft. and return | 54 | 9.9 | 21.0 | 92.3 |
| B railroad shops | Rectangular 64 ft. horizontally and 49 ft. vertically | 45 | 2.7 | 4.6 | 33.0 |
| C electric lighting company | Rectangular 152 ft. horizontally and 52 ft. vertically | 45 | 3,3 | 5.0 | 30.40 |
| D department store | Vertically 114 ft. horizontally 75 ft. and return | 42 | 6.17 | 15.4 | 40.0 |
| E navy yard | Rectangular 103 ft. horizontally 33 ft. vertically | 46 | 3.0 | 5.0 | 30.0 |

Conveyor drives reciprocating feeder

3 months' time were made to last over 4 years under exactly the same conditions.

### Carrying Pulleys

Mr. Baldwin showed that running at 400 ft. a minute for 8 hr. a day and 300 days a year, a belt can travel 57,600,000 ft., and that for a concaved roller, the smaller diameter being 8 in., and the larger diameter 12 in., the slip on the belt will be 2000 miles a year. He gave as the proper spacing of troughing idlers the following, depending on the weight of material carried. For 12 to 16-in. belts, 4.5 to 5 ft. apart; for 18 to 22-in. belts, 4 to 4.5 ft.; for 24 to 30-in., 3.5 to 4 ft.; for 32 to 36-in., 3 to 3.5 ft.

Where rubber belts are used, lubrication of the

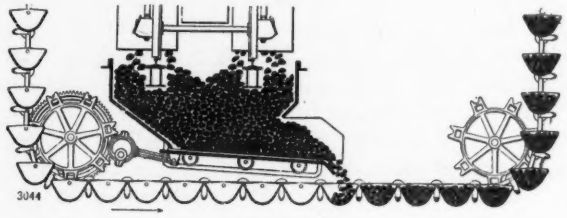

FIG. 4. RECIPROCATING FEEDER FOR COAL CONVEYOR

idlers is an important matter, as oil or grease soon causes the rubber to deteriorate. Oil should not be used, as it leaks out when the conveyor is not running and soon coats the faces of the pulleys and the belt. Conveyors usually work in dirty places where it is impossible to keep the oil wells clean, and grease lubrication through hollow shafts is generally used. Such bearings are practically dust proof, any foreign matter being carried out by the grease and a small ridge of grease is formed on the hubs of the pulley, making a most efficient dust collar. The great advantage of clean bearings, coupled with low power requirements of the belt conveyor, has resulted in a general adoption of this method of lubrication. The return belt is carried on straight idlers which should be placed from 8 to 12 ft. apart according to the weight of the belt.

### Construction of Rubber Belts

Briefly, rubber belts are made as follows: The duck is run through the calendar which consists of a series of heated rolls. This machine coats the duck with rubber, known as "friction." This frictioned duck is then cut into the proper widths and the belt is laid up to the desired number of plies, the operator using a hand or power roller to cause the plies to stick together. The cover is then put on and the belt put in the vulcanizing press, where it is subjected to heat and pressure. The belts are stretched before being vulcanized.

It will be noted that the belt consists of 3 parts: First, the duck, which gives tensile strength; second, "friction," which cements the plies of duck together; third, the rubber cover, which protects the duck from moisture and abrasion.

Cotton duck used in the manufacture of belts is made in bolts about 375 to 400 ft. long. Belts longer than this should be joined with metal lacing. Internal splices should be avoided, and special lengths of duck, while sometimes used, generally cause delay and increased cost and are not to be recommended, especially in wide belts, on account of the increased weight of the roll of belting to be handled in shipment and erection.

In order to be durable, a belt must be made with proper regard to the location of the stitched lengthwise seams, as if these are not properly placed the belt is liable to go to pieces in a short time. The life of the belt is represented by the life of the rubber covering, as with a thin layer of rubber, handling iron ore, the life of the layer of rubber was found to represent half the life of the belt. The function of this cover is to protect the body from moisture and abrasion and it must, therefore, be soft, pure and durable

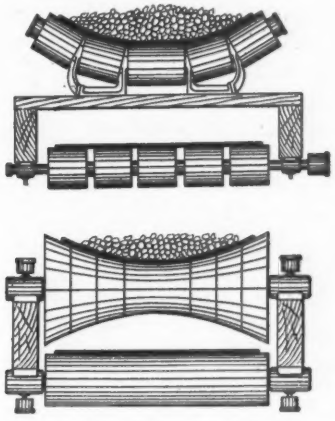

FIG. 5. RECENT TYPES OF ROLLER SUPPORT FOR BELT CONVEYORS

and still not too high in cost. Rubber belts are absolutely waterproof only when the cover is whole, as friction coats only the surface of the duck and is not absorbed by it.

It will be noted that both the cotton and rubber belts lack the property of being absolutely water proof. The only belt, which to the writer's knowledge possesses this quality, is the Dick's Balata Belt.

Balata is a vegetable gum found in Venezuela and the Dutch East Indies. In nature it lies between gutta percha and india rubber, but differs from them in its great tensile strength, freedom from oxidation, and the fact that it does not deteriorate with age. It is dissolved properly in but one solvent, the nature of which is a carefully guarded secret of the manufacturers.

The duck used in the Dick belt is woven by a special process on powerful looms, making it a compact, closely woven, and non-stretching fabric. The Balata is applied to the fabric in a liquid form so that the gum penetrates and saturates every fiber of the fabric, thoroughly waterproofing same. This

belt is not only water proof, but it possesses about 20 per cent greater tensile strength than a rubber belt of the same number of plies, due to the more closely woven fabric and the greater strength of Balata as a friction. For lighter materials, the Balata Belts are used without cover, but when heavy abrasive materials are to be handled a rubber cover is provided to protect the fabric from wear.

### Making Belts

There are 2 points which determine the number of plies of duck making up a conveyor belt. First, there must be a sufficient tensile strength; second, the belt should have enough stiffness to support the load properly between idlers. With the speed and the power transmitted known, the stress in the belt per inch of width may be determined and this stress should not exceed 18 to 20 lb. per inch per ply on the rubber belts. Where the power required is small, the stiffness of the belt fixes the number of plies. From 12-14 inch they should not be under 3 ply; 16-20 inch not under 4 ply; 22-28 inch not under 5 ply; 30-36 inch not under 6 ply.

Belts are sometimes made endless in the factory, but they are difficult to install and nothing is gained, so this practice is not recommended.

Lapped splices have been vulcanized in the field

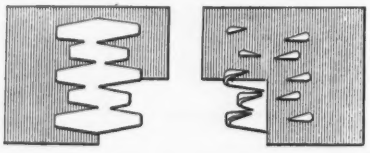

FIG. 6. METALLIC LACING FOR RUBBER BELTS

with a portable press, but this requires an expert and is very difficult, as all moisture must be dried out of the duck, otherwise steam will form when heat is applied, forming a blister in the splice. Lapped cemented splices are sometimes used, copper tacks being driven through the belt to hold the edges down. All of these methods are necessary in some cases, but generally a metallic lacing like the Bristol or the Crescent are the most satisfactory. These lacings are strong, are easily put in and do not seriously damage the ends of the belt, provided that the holes are first punched with an awl. When the belt becomes worn at the edges of the lacing, it is a simple matter to cut the lacing out and put in a new row.

### Driving Machinery

The belt conveyor has one great advantage over most other types of conveyors, in that it may be driven from any point in its length. When properly designed, the drive located at the tail or loading end will prove as satisfactory as when at the head. The drive may be located on the return or lower belt at any point between the head and tail ends with satisfactory results. The longest heavy duty belt conveyor ever built (1000 feet from center to center, handling about 400 tons of material an hour) is driven from the loading end. This feature of being able to apply the power to the conveyor at any point in its length, is of great value in the design of plants, particularly with conveyors of large capacity.

The driving machinery for the belt conveyor is extremely simple. Power is applied to one or more of the pulleys over which the conveyor belt passes. These pulleys should have heavy arms and rims with extra high crowns, and should be secured to their shafts by both keys and set screws.

Formerly the driving pulleys were increased in diameter as the duty increased, so as to obtain a greater arc of contact. In recent years multiple pulley drives have been used on the longer conveyors with most satisfactory results. In this type of drive, the belt passes over 2 or more pulleys geared together so that they will turn at the same speed. This makes it possible to use smaller pulleys, thereby simplifying the speed reduction from the motor or engine. For example, a conveyor with a belt speed of 400 feet a minute having a driving pulley 48 inches in diameter making 32 r. p. m. and driven by a motor at 800 r. p. m. will require a reduction of 25 to 1. If a multiple pulley drive made of 2 24-inch pulleys is used, the reduction will be only 12.5 to 1. With a single pulley drive, the belt must always be under the proper driving tension fixed by the take-ups. With the multiple pulley drive, however, the belt may be run as slack as desired provided there is some means of keeping the belt in contact with the second drive pulley, by allowing it to sag or using a weighted take-up.

Pulleys of small diameter should be avoided on the heavy belts, otherwise the constant bending when under heavy stress will cause the friction to lose its hold and destroy the belts. In many cases it is advisable to cover the driving pulley with a rubber lagging to increase the tractive power, particularly when the conveyor operates in a dusty place.

Only 2 or 3 sizes of pulleys are required for each width of belt to make up drives for conveyors of the various lengths. A short conveyor may be driven by a single bare pulley; a longer conveyor may be driven by a pulley of the same diameter if it is covered with rubber. Still longer conveyors would use a 2-pulley drive with bare pulleys. These in turn may be rubber covered, giving still greater tractive power. The faces of all pulleys should be at least 2 inches wider than the belt. At some point in the length of the conveyor, a pair of take-ups should be used to take up the stretch in the belt, and to adjust same should the splice not be exactly square.

### Chutes and Feeders

It is impossible to lay down any rules for chutes. It is a subject requiring a careful study of local conditions and a complete knowledge of the materials

handled and of the manner in which they will move in chutes under various conditions.

The material should always be delivered to the belt in the direction of the belt travel and as nearly as possible at the same speed, so that it will go from chute to belt with no shock or jar. When feeding a conveyor from bulk, for example, from storage bin, some type of automatic feeder should be used to insure an even and continuous feed to the belt. This is particularly important when handling unsized material. Should a simple gate be used, it must be set for the large lumps, the result being a rush of fine material after the lump has passed. If a feeder is so driven that it will start and stop with the conveyor it feeds, it will generally save the expense of an attendant at the loading end and prove more satisfactory.

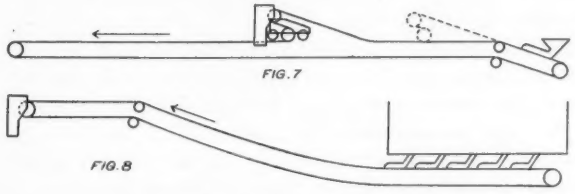


FIG. 7. ARRANGEMENT OF BELT CONVEYOR AND DISCHARGE
FIG. 8. COMBINED INCLINED AND LEVEL CONVEYOR

The writer favors the shaking feeder consisting of an inclined pan set under the bin opening at such an angle that it stops the flow when stationary. When given a reciprocating motion by crank and connecting rod the material is moved along the pan to the belt. By varying the length of stroke and inclination of the pan the amount of material delivered may be closely regulated.

### Capacity

Belt conveyors may be built to handle practically any quantity of material which may be fed to them. Table V gives the capacity, maximum size of lumps, and advisable speed for the different widths of belts. This table is based on an even and continuous flow of material to the conveyor and in choosing width and speed, a full knowledge of the local operating conditions, and character of the material, is necessary so that the table may be used with judgment.

### Speed and Size of Belts

When the quantity to be conveyed is small, and the pieces large, the size of the material fixes the width of the belt and the speed should be as low as possible to safely carry the desired load.

When the quantity is great, the capacity fixes the width and in this case also the speed should be as slow as possible. A slow speed belt may be loaded more deeply than one at high speed and when a narrow belt is run much above the advisable speed, the load thins out and the capacity does not increase as the speed.

The maximum length of the different widths of conveyors is determined by the fiber stress in the belt and is therefore closely related to the load and speed. Naturally level conveyors may be built longer than those lifting material. Conveyors 1000 ft. from center to center handling 500 tons an hour have been most satisfactorily operated.

Another important factor in the design of conveyors at high speed, handling large quantities, is the flow of material in the chutes. A 36-in. conveyor handling 750 tons of coal an hour with a belt speed of 750 ft. a minute under a 10,000-ton pocket could not be loaded from a single chute, because it was not possible for the coal to attain a speed of 750 ft. a minute in the chute. It was necessary, therefore, in order to obtain a full load to open 7 gates, each placing a layer of coal on the belt until the desired load was obtained. During a test this belt carried about 800 tons an hour.

### Power Required.

The power required to drive a belt conveyor depends on a great variety of conditions such as the spacing of idlers, type of drive, thickness of belt, etc.

TABLE V. SPEED AND CAPACITY OF BELT CONVEYORS

| Width of Belt | Maximum size of pieces | Capacity in cubic feet per hour at a belt speed of 100 ft. per min. | Capacity in tons per hour, at a belt speed of 100 ft. per min., material weighing 100 lb. per cu. ft. | Maximum advisable speed in feet per minute | Capacity in cubic feet at the maximum advisable belt speed | Capacity in tons per hour at the maximum advisable belt speed material weighing 100 lb. per cu. ft. |
|---|---|---|---|---|---|---|
| 12 | 2 | 460 | 23 | 300 | 1380 | 69 |
| 14 | 2½ | 630 | 31 | 300 | 1890 | 94 |
| 16 | 3 | 820 | 41 | 300 | 2460 | 123 |
| 18 | 4 | 1040 | 52 | 350 | 3640 | 182 |
| 20 | 5 | 1280 | 64 | 350 | 4480 | 224 |
| 22 | 6 | 1550 | 78 | 400 | 6200 | 310 |
| 24 | 8 | 1850 | 93 | 400 | 7400 | 370 |
| 26 | 9 | 2180 | 110 | 450 | 9810 | 490 |
| 28 | 12 | 2500 | 125 | 450 | 11250 | 563 |
| 30 | 14 | 2900 | 145 | 450 | 13050 | 653 |
| 32 | 15 | 3300 | 165 | 500 | 16500 | 825 |
| 34 | 16 | 3700 | 185 | 500 | 18500 | 925 |
| 36 | 18 | 4200 | 210 | 500 | 21000 | 1050 |
| 38 | 19 | 4600 | 230 | 550 | 25300 | 1265 |
| 40 | 20 | 5100 | 255 | 550 | 28050 | 1402 |
| 42 | 20 | 5600 | 280 | 550 | 30800 | 1540 |
| 44 | 22 | 6200 | 310 | 600 | 37200 | 1860 |
| 46 | 22 | 6800 | 340 | 600 | 40800 | 2040 |
| 48 | 24 | 7400 | 370 | 600 | 44400 | 2220 |

In figuring the power required, it is important to remember that the belt should be run no faster than is required to carry the desired load. If for any reason it is necessary to increase the speed, the load should be increased in proportion and the power figured accordingly. In other words, the power should always be figured for the full capacity at the chosen speed.

The horsepower equals the constant from Column 1 of Table VI, multiplied by the load in tons per hour and by the length of the conveyor between centers in feet and divided by 1000. This will give the horsepower for level conveyors. For inclined conveyors add to this amount the load in tons per hour multi-

plied by the height of the vertical lift in feet and divided by 1000.* For each movable or fixed tripper add the horsepower found in Column 3 of Table VI. Add 20 per cent to the horsepower for each conveyor under 50 ft. in length. Add 10 per cent to the horsepower for each conveyor between 50 and 100 ft. in length. The above figures do not include the gear friction if the conveyor is driven by gearing.

With the horsepower and speed known, the stress in the belt should be figured by multiplying the horsepower by 33,000 and dividing by the belt speed in feet per minute times the width of the belt in inches.

With this value known, the number of plies may be determined, using 20 lb. an inch per ply as the maximum. The columns 4 and 5 of Table VI give the maximum and minimum advisable plies of the different widths of belt. Belts between these limits will trough properly and will be stiff enough to support the load. The maximum number of plies determines the maximum length for each width of conveyor.

TABLE VI. POWER CONSTANTS FOR BELT CONVEYORS

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Width of Belt | C for material weighing from 25 lb. to 75 lb. per cu. ft. | C for material weighing from 75 lb. to 125 lb. per cu. ft. | H. P. required for each movable or fixed tripper | Minimum plies of belt | Maximum plies of belt |
| 12 | .234 | .147 | ½ | 3 | 4 |
| 14 | .226 | .143 | ½ | 3 | 4 |
| 16 | .220 | .140 | ¾ | 4 | 5 |
| 18 | .209 | .138 | 1 | 4 | 5 |
| 20 | .205 | .136 | 1¼ | 4 | 6 |
| 22 | .199 | .133 | 1¼ | 5 | 6 |
| 24 | .195 | .131 | 1½ | 5 | 7 |
| 26 | .187 | .127 | 2 | 5 | 7 |
| 28 | .175 | .121 | 2½ | 5 | 8 |
| 30 | .167 | .117 | 2½ | 6 | 8 |
| 32 | .163 | .115 | 2½ | 6 | 9 |
| 34 | .161 | .114 | 3 | 6 | 10 |
| 36 | .157 | .112 | 3½ | 6 | 10 |

In Fig. 7, the material is received at one end and discharged at any point in the length by a movable tripper. The tail end is usually depressed as shown so that the belt will not be raised against the loading chute by the tripper when discharging near the tail end as shown in dotted lines.

With the simple inclined conveyor, practically any material may be carried up 20 deg. to the horizontal when run at proper speed and with correctly designed chutes. With sized material, such as sand, crushed ore, stone or coal, the angle may be increased to 22 deg. and under some conditions, even more. When elevating material containing large lumps, the lumps have a tendency to roll back on the layer of fines so that the angle should not be over 20 deg. Inclined conveyors should not be run at high speeds, as the material must be given the same speed as the belt and the higher the speed the more the slip at the loading point and the greater the wear on the belt.

Figure 8 is the combination of inclined and level conveyor with vertical curve, which is largely used. Where the belt passes from the incline to the level it should not pass over a troughing idler but over a high crowned pulley.

It is frequently advisable to run conveyors on a vertical curve. The radius of the curve depends on the size of the belt, location of the drive and the local conditions. It is possible so to design these conveyors that the belt will touch the troughing idlers, whether loaded or light.

Advantages of the belt conveyor summarized by Mr. Baldwin are: Large capacity with low power; small maintenance charges; freedom from shutdown; light weight; material in contact with no moving parts but belt; perfect alinement not necessary; adaptability to portable plants; large overload capacity.

### Tests of Belt Conveyors.

Edwin J. Haddock of the Jeffrey Mfg. Co., Columbus, O., gave the results of a series of tests with conveyor belts. As to the effect of diameter of driving pulley on tractive force, he concluded that, if a pulley is not less than 5 in. in diameter for every ply of belt, it will give its maximum of tractive force. Below this diameter the belt will not adhere closely to the pulley.

With respect to the effect of arc of contact, he found that the load carried varied almost in proportion to the arc up to 180 deg.; above that arc the pull increased rapidly.

Tests on the strain permissible showed that 40 lb. per inch of width per ply may be used, but this is the maximum permissible; better practice is 30 lb. A rubber covered pulley showed an advantage of 7 per cent over an iron faced pulley.

For finding the power required Mr. Haddock gives for the average case the following rule: 0.15 × total weight of belt + 0.07 × pounds material per minute; multiply this sum by the length of the conveyor in feet; multiply the pounds of material per minute by the height to which it is lifted by the conveyor and add this product to the one previously found; divide the sum by 33,000 and the quotient will be the horsepower.†

In addition allow 4 to 6 per cent for each tripper.

For belts with a vertical curve the arrangement should be such that the belt will rest on the idlers in catenary or natural curve form.

*In equation form:

Hp. equals $\frac{C \times T \times L}{1000}$ for level conveyors,

Equals above plus $\frac{T \times H}{1000}$ for inclined conveyors,

Where C equals constant from table, T equals load in tons an hour, L equals length of conveyor between centers in ft., H equals vertical lift for material in ft.

†Hp. equals $\frac{(0.15W^1 \text{ plus } 0.07W)\ L \text{ plus } HW}{33{,}000}$.

Where W equals total pounds delivered per min., $W^1$ equals total weight of belt, lb., L equals length of conveyor, ft., H equals height to which material is lifted.

## SETTING BOLTS IN CONCRETE FOUNDATIONS.

IN building concrete engine foundations it is necessary to leave holes of considerable size for the holding down bolts, these holes to be afterwards filled up when the bolts are in place. Wood boxes are often used to form the holes, and these have to be withdrawn after the concrete of the foundation is

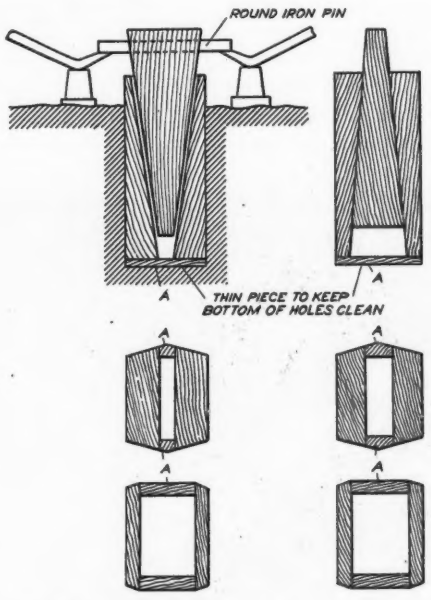


FIG. 1. SOLID TAPERED FORMERS FOR FOUNDATION BOLT HOLES IN CONCRETE

set. It is necessary to get them loose in some way from the concrete, either by breaking them in, or drawing on a taper, and the following are some methods which have been used to good advantage:

### Wedge Boxes

First, a taper form of solid pieces, with a center wedge, which may be either drawn out or knocked down in and the whole structure withdrawn from the hole. This form is used soaked with water, and shrinks as the concrete dries out. The wedge faces are well coated with tallow and graphite and pieces A are made thin and broken out before withdrawal of the pieces of the former.

Another suggestion is to wrap the boxes with two thicknesses of oiled paper so that the concrete cannot touch the wood. The boxes will then come free, leaving the paper wrapping, which can be dug out.

### Tapered Boxes

Still another form is that shown in Fig. 2. The box being nailed as lightly as will serve to hold it during the building of the foundation. If the depth is over 4 ft. it is better to taper the box slightly. In removing, a long bar is forced down between the concrete and one side of the box, splitting that side, when the other 3 sides can be taken out whole. The outer surfaces of the boxes should be well rubbed with soft soap. If the concrete be loosely packed around the boxes instead of ramming hard, it will have a rough surface, which gives a much better grip for the later grouting.

One ingenious device is the building into the box of a piece of gas pipe, to which a hook can be attached for withdrawing. This, with a taper box well oiled and shaken sidewise slightly before the concrete sets, makes an easy job.

### Metal Boxes

In metal boxes, a piece of steam pipe may be used, with the top end screwed and fitted with a flange to

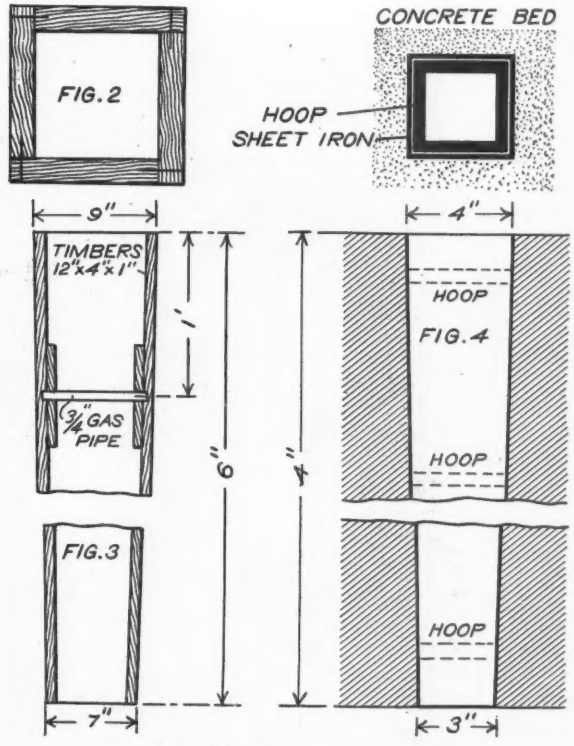


FIG. 2. LIGHT BOX CONSTRUCTION
FIG. 3. TAPERED BOX WITH GAS PIPE BUILT IN
FIG. 4. SHEET IRON BOX WITH FRAMES

give a pry for a lever. By rapping with a hammer and then pouring water around the pipe it will come out easily. Sheet iron may be used by cutting it taper 1 in. in 4 ft. and holding it out in place by frames put inside the sheets. These frames are pulled out with a hooked rod after the concrete is set, and the sides will then come free.

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"ADVANCEMENT COMES only through good hard work, diligent application, faithful performance, correctness, accuracy and that fine display of judgment which flows only from a well-ordered mind, capable of thinking independently, acting resolutely and fearing nothing."

# GAS ENGINES AND PRODUCERS

## A UNIQUE FOUR-CYLINDER SCOTCH YOKE GAS ENGINE

THE accompanying illustrations show the design and construction of a 4-cylinder gas engine of the horizontal opposed type which is of special interest. One of the most striking features of this engine is the use of a modification or development of the Scotch Yoke in place of connecting rods.

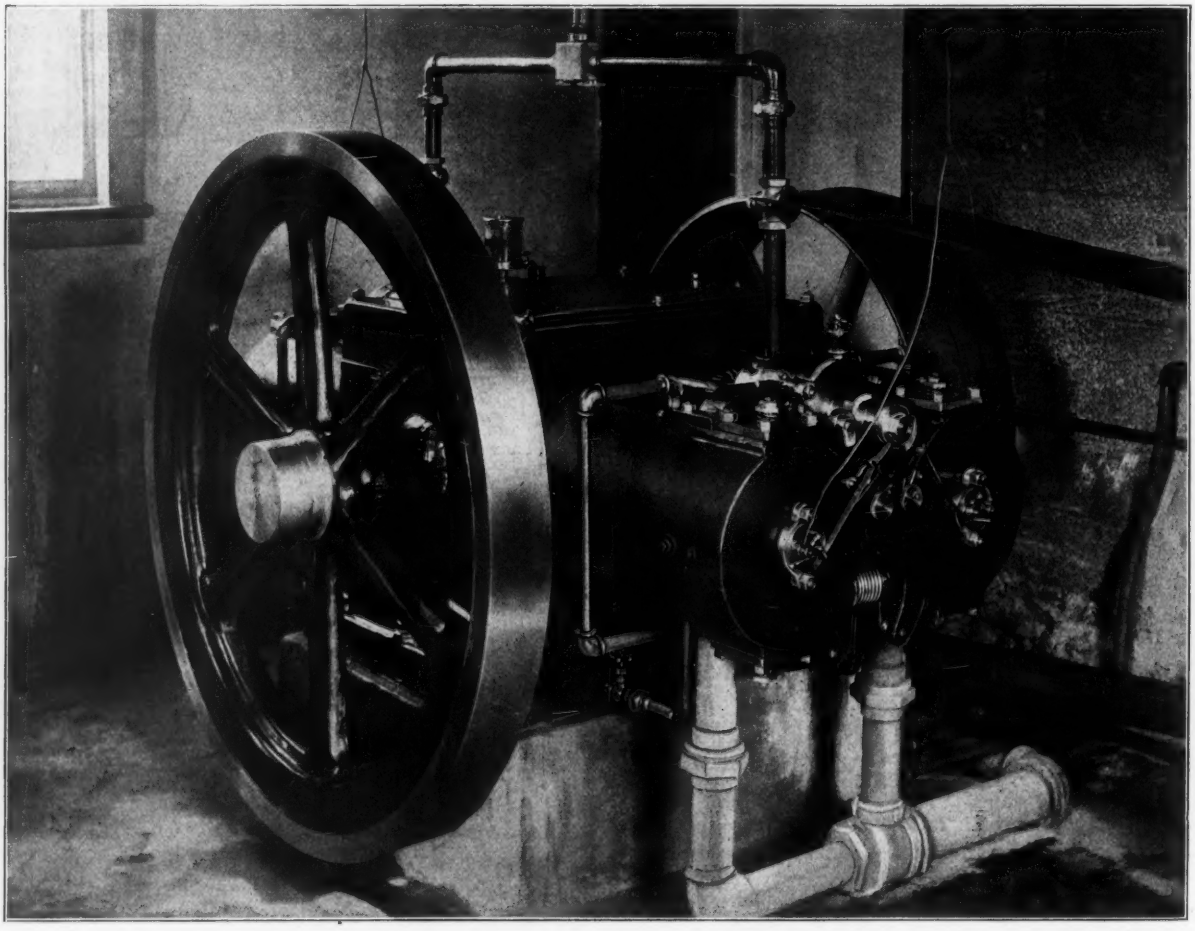

FIG. I. THE OLIN SCOTCH YOKE GAS ENGINE

Many engineers have long considered the Scotch yoke a mechanical impossibility, except for light and a very limited field of service, owing to the excessive friction on the slides, the unequal pressures, and consequent unequal wear which quickly destroys the surfaces.

It was held by F. C. Olin, the inventor of this engine, that, if means could be introduced to practically eliminate the wear and friction, it would make the Scotch yoke practicable for engine and other severe work. It is a well known fact that when either balls or rolls are properly introduced into machinery design, both the wear and friction are almost entirely done away with.

It will be seen that the engine shown in Figs. 1 and 2, has cylinders, between which are introduced the yoke pieces and slides. As a result of this construction, quite a number of important and valuable features are gained. The extreme floor space of the 9 by 11-in. engine is only 5.5 by 6 ft. The weight for stationary work with 4-in. crank shaft and other parts in like proportion, is only 4600 lb. and the

height only 56 in. The angular thrust and consequent friction and wear of cylinders and pistons, due to the use of connecting rods, is done away with.

It is said to have all the advantages of an engine with crosshead and guides for 4 cylinders. It is claimed that the mechanical efficiency is high, about 90 per cent. The engine is symmetrical in its lines, opposing cylinders being set directly opposite each other. The pistons, yokes and slides by their webbed construction, are light as well as strong, thus minimizing the inertia affect. The balls are held in cages under elastic tension, which entirely prevents noise or rattle, and run upon hardened steel runways.

In Fig. 2, is shown a yoke, crank box and two pistons, also a separate cage of balls. The governor and governor valves are of the cutoff type, thus effecting the greatest economy of fuel.

For lubrication, oil is pumped in continuous streams upon the internal working parts, insuring satisfactory lubrication of pistons, main bearings, crank yokes and governors.

The illustration, Fig. 1, shows a 9 by 11 in. engine of this type, of 60 horsepower nominal capacity, installed in St. Anne's Catholic Church at Buffalo, New York, and furnishing current of about 250 amperes, and it also furnishes the current required to light a large hall capable of seating 2000 people.

# POWER PLANT OPERATION ON PRODUCER GAS*

By Godfrey M. S. Tait

BESIDES the three chief types of gas producers, the up-draft, the suction and the down-draft, there are various arrangements and combinations of up and down draft for the double purpose of keeping the fuel beds well broken up and for generating special qualities of gas.

Unfortunately the utilization of these plants in this country has been attended with considerable difficulty, due to the unsatisfactory nature of American fuels, high in fusible ash.

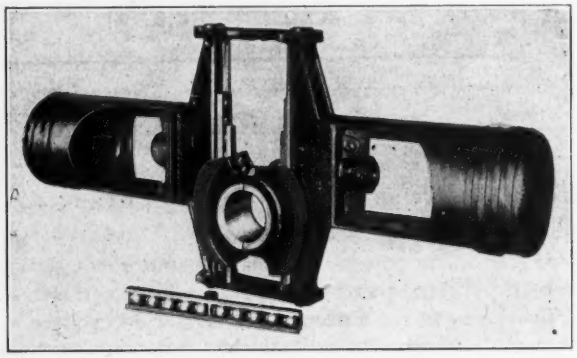

FIG. 2. PISTONS, YOKE AND CROSSHEAD OF OLIN ENGINE

To explain this point, it will be noted that the producer business in Europe has reached a very much more advanced stage than in this country, and upon investigation it was found that this was almost entirely due to the fact that the European coals employed have little if any fusible ash, and a high percentage of fixed carbon which enables the operation of these plants at a rate of gasification per square foot of inside area entirely out of the question in this country, as the temperatures so obtained would fuse our ash into a regular slag.

However, all attempts to obtain such results in this country have failed, for the reason that in order to obviate troubles from clinkers, due to the high percentage of fusible ash in American fuels, it was found necessary to make the grate surface very much larger per horsepower than was the case in foreign practice, and while this change practically obviated clinker troubles, we found ourselves confronted with an even worse difficulty, due to the fact that on half or quarter load, the temperature of the combustion zone in the producer was very much below the point necessary for the complete dissociation of the steam supply for the producer. This gave us a gas which from 5000 or more analyses which the writer has made, showed considerable variation, the hydrogen constituent varying anywhere from 5 to 20 per cent by volume of the gas generated according to the temperature of the combustion zone in the producer, which in turn was absolutely controlled by the amount of load on the plant.

While this variation in the hydrogen constituent was of comparatively little moment, when the operation of furnaces with gas was considered, on the other hand it produced a very serious defect when using this gas for the operation of engines. Not so much for the reason that the total British thermal units changed, because such change was slight, and should have been handled by the governors on the engine, but that as hydrogen burns approximately twice as rapidly in an engine cylinder as carbon monoxide, and the ignition point was usually set for the more rapidly burning hydrogen, it followed that when this fell off in quantity, the engine would be firing too late to be economical, also the late fire caused excessive heating of the exhaust valves.

Having obtained this information, the writer then set about to obtain if possible some other means of producer operation, so as to eliminate the most changeable part of the gas, namely hydrogen, in order to get an absolutely fixed ignition point.

A producer was equipped with a draft supply consisting of pure air alone, and yielded a gas consisting

*Abstract of a paper presented before the American Society of Mechanical Engineers.

essentially of carbon monoxide and nitrogen, with only a slight percentage of hydrogen. This gas had a value of about 105, which was of course very much lower than would have been the case had the usual steam saturated draft been employed.

On the other hand, although having a lower heating value, the fixed ignition point of the gas and its uniformity of composition was very striking, and but for the fact that the producer became overheated to such a degree as to cause clinkers from the fusible ash in the coal, satisfactory results would have been obtained.

This gas washed and scrubbed in the usual manner, and used for the operation of a 100 hp. 3 cylinder vertical engine remedied trouble from premature ignitions at certain loads and what was perhaps more surprising still, by an advance of the igniters to the correct position, it developed horsepower slightly in excess of its builder's rating. After making a short run under these conditions, it was found possible by increasing the compression of the engine to 200 lb., combined with setting the igniters at exactly the right point, to carry about 15 per cent more power on the engine than the builders cared to guarantee.

This and other similar experiments proved that the most essential feature in a power gas is its uniformity of composition, which in turn means its fixed ignition point, and that no matter how low the British thermal units within reasonable limits, it is perfectly possible to operate the gas engine successfully, provided that the ignition point always remains the same.

After settling this fact thoroughly by continued experiments, the writer then looked about for some means of cooling the fire to take the place of the usual steam saturated draft, and finally decided that the use of carbon dioxid in fixed amounts might answer the purpose.

The exhaust from the engine was piped back with a by-pass to a mixing valve on the producer, so arranged that part air and part exhaust could be admitted to the ash pit. With a proper mixture of exhaust and free air the producer could be operated at a sufficiently high temperature to make gas, while at the same time, low enough to obviate any dangers of clinkers from the fusible ash.

Figure 1 shows an elevation of a complete producer and engine plant of this kind which was installed in Brooklyn about 18 months ago. The plant consists of a gas producer of the suction type equipped with the usual coal feeding hopper but having no evaporator or other vapor supply; this producer is supplied with the usual down take pipe 5 communicating with a two-way valve 8 for throwing the purge pipe into operation when the plant is shut down, scrubber 11, purifier 12 and gas pipe 13, which in this case delivers gas to the automatic exhauster 14, a piece of apparatus which will be described later. From here the gas flows through pipe 18 to the 2 engines shown.

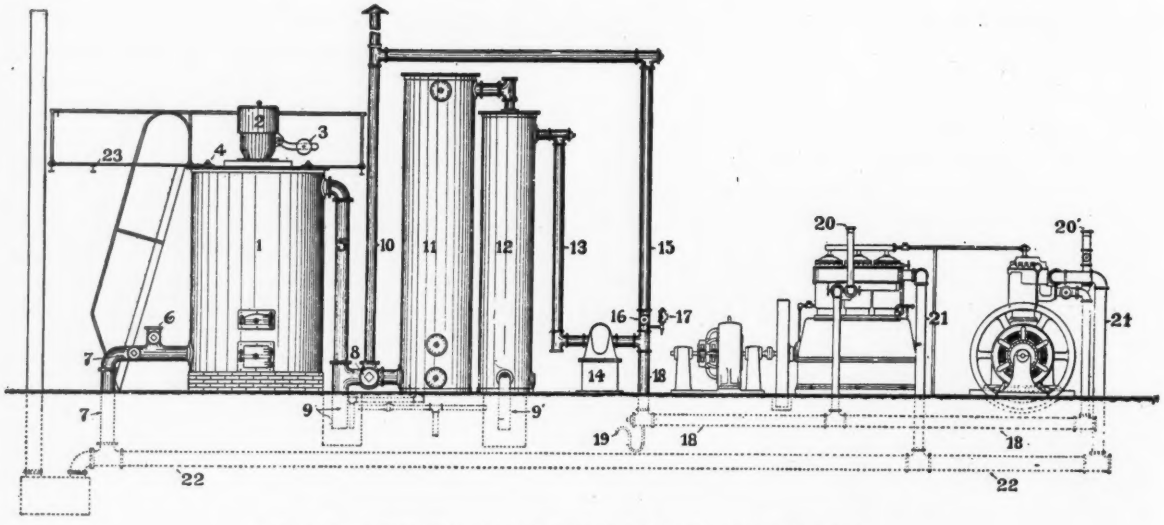


FIG. I. ELEVATION OF GAS PRODUCER AND ENGINE PLANT

The exhaust from the engines passes off through pipes 21 to the exhaust main 22, which leaves the building at a point under the producer and is bypassed through pipe 7 up to the mixing valves 6 and 7 where air and exhaust gases enter the base of the producer.

The aparatus 14 which is shown in Fig. 2 consists of a positive type exhauster operated by motor or other suitable means, and which draws the gas from the producer as indicated by the arrow points, and discharges it toward the engines at a predetermined and absolutely fixed pressure.

This pressure regulation is simply obtained, by the fact that the outlet of the exhauster communicates through several pipes, as shown in the drawing, to a seal of water contained in the base of the apparatus, this seal of water being set to the desired point to give best results at the engines. Any excess gas bub-

bles up through this water seal, returning to the inlet side of the exhauster. This apparatus takes the place of the usual gas holder and enables the engines to be operated in parallel from the same suction producer. It is not an essential part of the experiment above alluded to but it was found to assist greatly in steadying up the conditions upon which the plant operated and was absolutely necessary to close regulation when it was desired to operate more than one engine from a single suction producer.

The plant of which Fig. 1 is an illustration has now operated for about 18 months, part of the time

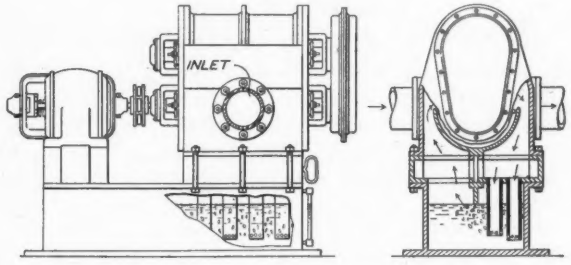


FIG. 2. TAIT AUTOMATIC GAS REGULATOR

24 hours a day, 6 days a week, and at loads varying from 0.25 to 10 per cent above builder's rating, and has during that entire period given no trouble from variations in the quality of the gas, such as would have been encountered, had this gas been generated in the usual manner and containing the usual fluctuating amount of hydrogen.

Furthermore it was ascertained in practice that the exhaust pressure in the ash pit was just sufficient to offset the suction caused by the gas being drawn off the producer, with the result that the poke-holes on top of the producer could be opened and kept open without any gas escaping or any air getting into the producer, and for this same reason it was found possible to open the ash pit and grate bar doors wide and to clean the fires thoroughly while the full load was on the engines, without in any way interfering with the quality of the gas. This latter point proved very satisfactory with the operators of the plant, as it enabled them to clean their fires while the daily run was going on and no time had to be charged to this operation. Also the pulsation of the exhaust gives a beneficial shaking action upon the fuel bed in the producer and seems entirely to obviate the tendency for fissures to form in the fuel bed, with the result that the average carbon dioxid obtained in the producer gas made under this arrangement is only 1.5 per cent, which, compared with the average obtained under the old method of producer operation, shows a great saving.

While from a thermal standpoint it is a doubtful question whether the producer itself is as efficient a converter of heat values, under this system, as when using a steam saturated draft under test conditions, it has been found in actual practice that the fuel saving on the plant is considerable, due to the fact that the entire absence of necessity for rebuilding the fire at any time and the ability to operate continuously, naturally lowered the fuel consumption to a remarkable degree. In fact, the actual coal consumption on this plant, taken for a period of 6 months, and including all standby losses, showed that the plant is burning 1.25 pounds of coal per brake horsepower per hour, while the load factor was less than 2/3, and the working day but 10 hours, and Sundays the plant was shut down. Further, when the occasion arose to operate this producer 24 hours a day at full load, it was found that the coal consumption was 0.7 lb. per brake horsepower developed during time of operation, and that this economy could be maintained for as long a period as the load conditions allowed.

## VAPORIZERS FOR GASOLINE ENGINES

By A. Edward Rhodes

BEFORE gasoline can be used in the cylinder of an engine, it must be converted into vapor and mixed with the proper proportion of air. Figure 1 represents the simplest form of mixing valve or vapor-

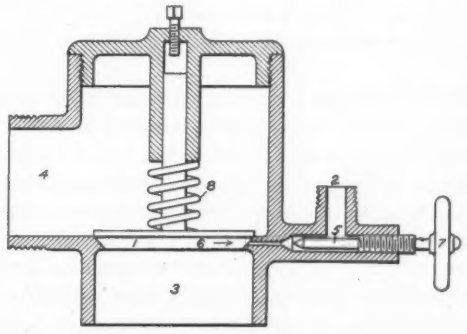


FIG. I. SIMPLEST FORM OF VAPORIZER

izer, in which the fundamental principle of operation is the gathering up of the gasoline by a current of air, thus forming a vapor or mixture of air and gasoline which is then ready for use. In practise, the gasoline flows out of a small orifice direct into a stream of air which is drawn in by the suction stroke of the engine.

### The Simplest Form

The proportions of gasoline and air must be nicely regulated, as the proper mixture is far more effective than one either too weak or too rich. All vaporizers, to properly perform their duties, therefore, should be provided with means for regulating the flow of both gasoline and air. Fig. 1 consists of a brass casting, containing the valve 1 and its seat, and provided with openings 2, 3, 4. This is screwed to the crank case of the engine by the threaded end 4. Gasoline enters at 2, flowing past the needle valve 5, into the small

opening 6, the amount of gasoline entering the opening 6 being regulated by the hand wheel 7, which screws the needle valve in or out as desired.

The valve has a spindle, or guide, extending upward, as shown, for properly seating the valve. The spring 8 is for returning the valve to its seat quickly without loss of crank case compression, thus allowing the engine to run at a higher rate of speed than would be possible without the spring. It will be noticed that the valve 1, when seated, completely covers the opening 6, thus preventing the escape of gasoline to the atmosphere.

### Operation of Valves

Now, suppose this vaporizer to be connected to the two-cycle engine illustrated in March issue of

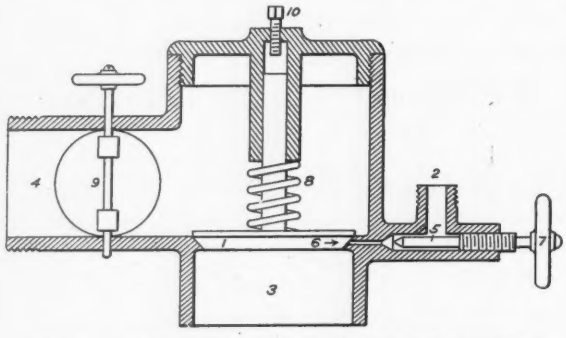


FIG. 2. VAPORIZER WITH VARIABLE AIR SUPPLY

the Practical Engineer. Then the suction created in the crank case by the up stroke of the piston causes the valve to rise and the air to rush in through the opening 3. The rising of the valve uncovers the small opening 6 and allows the gasoline to flow out and into the incoming stream of air, which immediately absorbs it. This mixture of gasoline and air passes into the crank case and is now ready for use, and to pass into the cylinder at the proper time.

As soon as the piston has reached the top of its stroke, and in consequence, the suction has ceased, the valve 1 returns to its seat by its own weight, aided by the spring 8, thus preventing the escape of the gases from the crank case during the downward or compression stroke of the piston.

Owing to its simplicity this vaporizer is especially suitable for small engines, where it will be found to give good results. Its greatest defect is that no provision is made for adjusting the supply of air, the gasoline supply, only, being variable; it consequently is not very sensitive, a fault that may be overlooked in the smaller sizes.

### Improved Form of Vaporizer

A better vaporizer is shown in Fig. 2. Here the principle of action is the same as before, with the addition of a throttle valve 9, consisting of a disk, which may be turned to close, partially or completely, the opening in which it fits, and of a screw 10, which screws down and regulates the lift of the valve 1.

These additions are for varying the proportions of the mixture of gasoline and air, which may be done as follows: The gasoline opening may be varied by the needle point 5, thus giving poorer or richer mixture as less or more gasoline is allowed to enter the opening 6. The air supply is regulated by the screw 10, which varies the lift of the valve 1.

These adjustments allow regulation to suit the different conditions of atmosphere, temperature, etc., under which the engine may have to run. For regulating the speed of the engine, the throttle 9 may be turned, thus regulating the amount of mixture admitted without changing its proportions.

### Float Feed Vaporizer

For the 4-cycle type of engine a vaporizer having a float feed is used, a type which is generally called a carbureter. Figure 3 illustrates a form much used. It consists of a chamber containing the float 11; leading from this chamber is a small opening 6, containing the needle valve 5. The gasoline enters at 2. At 12 is a small valve attached to the float

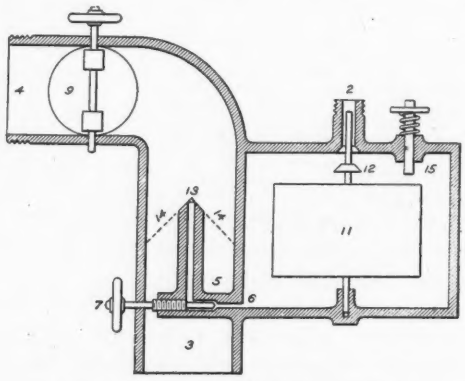


FIG. 3. FLOAT FEED CARBURETTER

which rises and closes the valve, the float is guided by 2 small rods, as shown.

Gasoline passes around the needle valve 5 and up the vertical tube to the opening 13, which is so adjusted that the level of the gasoline is just below it when the float is in its highest position and the valve 5 is closed. The air drawn in by the suction stroke of the piston rushes past the opening 13 and draws up and absorbs a portion of the gasoline.

At 14 is a cone of fine wire gauze which catches any gasoline not taken up by the air current, and holds it ready to be taken up at the next stroke. The float 11 is usually made of copper. The small plunger is for forcing the float down, by hand, for the purpose of flooding the opening and making certain the flow of gasoline.

When the engine is in operation, as the gasoline is drawn up by the air, the level in the float chamber falls slightly, finally opening the valve 12 and admitting gasoline and restoring the level in the tank chamber; whereupon the float rises, closes the valve 12

and stops the flow. Thus the level is maintained constant and the same amount of gasoline is drawn out at each stroke.

Although the actual details of different carbureters will differ greatly, the principles governing their action will be found to agree with the foregoing, and the several parts will be found in some one form or another.

Owing to varying conditions the relative adjustments will require changing from time to time; even for starting the engine a different adjustment may be required from that under which the engine will run after being warmed up.

## GETTING READY FOR THE EXAMINER

By A. C. Waldron.

THE following are some of the examination questions that Massachusetts engineers are required to answer when applying for a second or first-class engineer's license. The answers are those which I gave to questions asked me and to those others gave me.

1. Suppose that in taking charge of a plant with a new Brown engine for the first time, it would not start, where would the probable trouble be?

A. See if the safety catch had not been forgotten when shutting down the night before, which would allow the governor to drop to its lowest position. This would cause the safeties to keep the latches from hooking on. Next to the governor under the safety catch you will see 2 little levers about 2 in. long. The one on the left has an eccentric motion which, when pointing down, is in the running position. In case the safety catch is forgotten, pull this little lever towards you, or away from the engine. It will throw the safeties out and allow the valves to hook on. The right-hand lever acts as a lock nut.

After the engine is nearly up to speed, put these levers down or the engine will cut off too short to do much work.

2. What advantage is it in a Manning boiler to have a greater diameter at the bottom?

A. The larger area of the grate can be made in correct proportion to the heating surface.

3. How would you figure the horsepower of a compound condensing engine?

A. Multiply the area of the high-pressure piston by its m. e. p., and divide it by the area of the low-pressure piston. Add this quotent to the m. e. p. of the low-pressure cylinder. Call this answer No. 1. Multiply the area of the low pressure piston by its piston speed in feet per minute, and by answer No. 1, dividing the last product by 33,000. This will give the horsepower.

4. If a link motion had a straight link would the engine run?

A. If it had a straight link it would be all right if worked in full gear, but when hooked up, or at short cutoffs, it would be damaged by its movement.

5. If in figuring the waterleg of a vertical boiler you found the staybolts pitched, some 5 in., some 6 in., and some 8 in. apart, which would you take in calculating the safe working pressure?

A. As a boiler is no stronger than the weakest part, it is certain that where the pitch is 8 in., it is the weakest part of the waterleg as regards the staybolting.

6. How would it affect an engine if 0.25 in. was turned off the eccentric?

A. Turning off 0.25 in. from the eccentric would not affect the valve gear except that the eccentric rod or valve stem would have to be lengthened that amount.

7. Suppose that you saw a pressure on your receiver of 15 lb. on a compound engine, how would you lower it without lifting the relief valve?

A. By lengthening the low-pressure cutoff, causing the low pressure to take a greater volume of steam from the receiver.

8. How does the Robb-Mumford boiler differ from other boilers in regard to circulation?

A. It differs in that the circulation is down the front neck into the tubular section, along the same and up the rear neck into the main drum. In the ordinary horizontal water-tube boiler, curculation is down the back connection, up through the tubes and the front headers and into the steam drum.

9. Do you know of any boilers that have 2 blowoffs?

A. The Franklin, the Keeler, the Robb-Mumford, the Heine. One blowoff comes out of the bottom of the rear waterleg. The other comes out of the back head from a sleeve or mud drum inside the steam drum into which the feed pipe discharges. In the Robb-Mumford the blowoff comes out of the front end of the bottom of the drum.

10. If the back-pressure line on a high-pressure card from a cross-compound engine was considerably higher in the center, what would it indicate?

A. It would indicate that the receiver was too small or the exhaust valve did not open the port wide enough.

11. What would happen if one of the balls on the governor should drop off?

A. If the friction of the governor was not too great, the engine would speed up, and this would probably happen. The side twist of the single ball might, however, cause sticking for a short time. When one of the balls is removed it takes away half the centrifugal force, but on account of the arms and conncections, less than half the weight is removed. Hence, the weight would overcome the centrifugal force and the collar would drop, allowing the engine to speed up.

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IN A GAS ENGINE the heat is disposed of as follows: Useful work, 17 per cent; radiation loss, 15 per cent; water jacket, 52 per cent; exhaust, 16 per cent.

# PRACTICAL ENGINEER

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## VACATIONS

This word is associated commonly with fishing, baseball, sailing or what not; and to the worker whose days are spent under a roof, the out-of-doors is the blessedest part of it. But we need the out-of-doors all the year around, especially all the summer long in our spare hours and half days; we should not wait for the formal vacation period.

The rest of a vacation trip comes more from variation of occupation than from lack of it. Indeed, for the desk-worn man a busy hardening of muscles is the best vacation. On the trip, however, comes the chance to see how the other fellow is doing it—to get a glimpse of the latest progress in power machinery,—and to meet the men whom we want to know. Even if it be a fishing trip or a mountain climbing expedition, a stop over on the way or a tramp to the "sawmill" power plant will give a new point of view about some matters of the steam plant. In the backwoods are often found some of the most advanced ideas in water power plants and long distance transmission.

Double value will be had too, if the story of the findings of new ideas be written down and sent to Practical Engineer so that you get the benefit of the other fellow's trip as well as giving him that of yours.

## LOW PRESSURE TURBINES

Ability to utilize steam at very low pressures with advantage in economy is one of the strong points of the turbine. The reciprocating engine can get down to a certain point with lessened steam consumption as the vacuum is greater. But there comes a point where greater vacuum is followed by increase in steam used.

With the turbine, the more vacuum the better, with no limit. Hence, it becomes possible to start a turbine at 7 to 15 lb. absolute pressure and expand down to the lowest possible with good results; it doesn't pay, however, to start at less than 7 lb. This is what makes the turbine available as an appendix to a noncondensing reciprocating engine, the appendix giving as much power, often, as the main engine, and at practically no added cost for fuel. Most applications have been made in collieries and steel mills, where noncondensing engines are the rule. Results are so satisfactory that the design of new plants having a compound engine with smaller low-pressure cylinder than ordinary and a turbine on the end is likely to become common, as giving better steam economy than can be obtained from either reciprocating engines alone or turbines alone.

## FALL CROPS

Government reports on these are still most encouraging. Cotton is estimated to be 1,500,000 bales in excess of last year and corn 2,720,000,000 bushels as against 2,592,300,000 last year. Railroads have to move these crops and are putting their rolling stock, which has been lying idle, into shape. One road is negotiating for 2000 box cars, another has ordered 500 cars

and 10 locomotives, a third is looking for 200 box cars and 25 gondolas.

Pittsburg reports its mills practically all running full time. Other districts report mills starting up or returning to full time schedule.

On account of low prices, house building has kept on all over the country and those who have built have made a substantial saving, but they have used up all surplus stocks so that none is on hand. The call for material for building and repairing cars must be met by making it; and the railroads must have men to put their stock in order. Some of them are already increasing their working forces and one road has been able to restore its old wage scale. Boom times are not likely, and it is doubtful whether feverish activity is desirable, but good business is in sight for the fall and it's the first fellow on the spot who picks the best berries.

## STEAM CONSUMPTION FROM THE INDICATOR DIAGRAM

It is good mental gymnastics to figure out from an indicator diagram how much steam the engine is using per horsepower per hour. So far as giving any idea what the engine is really using, it is worthless. In the first place, the measurements required on the card are liable to some error, which is greatly magnified by the multiplication involved in finding steam consumption. In the second place, figuring from the card gives no indication of how much steam has been wasted by condensation during admission and by leakage. This error may be as much as 100 per cent or as low as 15 per cent, depending on the kind of valves and condition of the engine. With so large a possible error and no means of telling how much it is likely to be, "what's the use?" It is time that this moss grown fallacy was done away with.

## EDITORIAL CHAT

### License Laws

One fellow was recently explaining carefully on the corner that the state and city license laws are rotten, and then some. Maybe so, but mostly the kicking comes from those outside the license territory; some who want to get in and can't, and some who are scared for fear that the license boundary will spread until it catches them.

Occasionally there is a fellow among the older engineers in a license state who is a grumbler. Most likely his story happened thusly: He had or got a plant at fair pay which was some considerable of a snap; then he lay back and "let 'er run" while time and progress kept right on.

All of a sudden some fine spring morning the plant has to be enlarged or Mr. Man sees a big chance down the street. Then he wakes up from his Rip Van Winkle act, grabs an engineer's handbook and expects to gobble up in 10 days what his neighbors have worked and studied over during his 10 years' nap.

Up he comes for a higher grade of license and often down he goes without it. Whereupon he proceeds to cuss the license law and all that has to do therewith, both well and heartily.

Then again, and also in various places, are engineering schools, some of which agree to take any person with the normal number of eyes and fingers and make him into an engineer or fireman,—if he has the price. He is put through a series of exercises on models which are "exact duplicates" of the machinery used by the examiners and, in some cases is taught the answers to "the very questions used by the board of examiners."

All in 6 weeks he changes from a laborer to a "first class enigneer." (?) Maybe, if "first class" means primary class. Anyway, he can figure boiler braces, set the valves on a slide valve or a Corliss engine model and do various other stunts.

Then in full war paint and armed with a crackly diploma, he marches on the examination, very likely conquers it, and is turned loose on the public as a safe man to operate a steam plant.

He knows, down in his boot soles, that he has to get experience, and that means that he has to have a job, so any old wages look good to him. And, unfortunately, some employers are always on the watch for such men because they will work cheap.

Now this condition isn't any fault of the license law. The same thing would happen if there were no law, only that the man who wants to work cheap would start in without even the little knowledge that the school gives.

The way out of this is to have a license law, and then require that an applicant for license must have and prove at least 1 year's experience as fireman or oiler in a steam plant under a competent chief. Then, if he wants to, let him take the school course. He will understand what he is doing and why, and can handle his plant when he gets one.

### Counterbalancing Elevators

One of the fellows wants to know why the weight to counterbalance an elevator is made heavier than the car so that the car has to be pulled down instead of up. The why is thus; if you always had the same load, it would be best to make the counterweight just equal the car and load. Then the only work on the motor or pump would be to turn the wheels. But folks are "onsartin" and sometimes more, sometimes less of 'em want to ride.

There will be some load which will be about average, and, if the counterweight be made equal to this average plus the car weight, the motor will have, on the average, the least work to do in lifting and turning the wheels. Some places, where there is great change in the load, weights are put into the car at light load periods to balance the counterweight and give the motor less work to do. Queer notion that,—to put more weight on the car so that it will run easier. Just the same idea as getting both ends of a teeter alike.

# ELECTRICAL MACHINERY AND APPARATUS

## DOUBLE FLOW STEAM TURBINES

### INSTALLATION IN THE BRUNOT ISLAND STATION AT PITTSBURG

THIS station serves not only most of the railway systems of Pittsburg and Allegheny but a large part of the lighting for the same territory. By the installation of this type of turbine it was possible to install 23,000 kw. of machinery in the space which had been provided for 4500 kw. of engine-driven machinery. For this extension, a new boiler house is being erected which will contain 6 400-hp. Babcock & Wilcox boilers fitted with Roney stokers. The

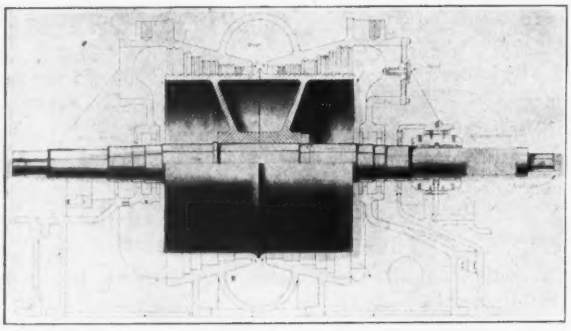

FIG. I. ELEMENTARY DOUBLE-FLOW TURBINE

boilers will be arranged in pairs discharging into 8 independent stacks 7 ft. inside diameter and 250 ft. high.

The turbines drive 11,000-volt, 3-phase alternators which are in electrical parallel with 6600-volt, 2-phase engine driven units. One 3000-kw. turbine unit has been in operation for a year, and 3 5000-kw. units are being installed.

#### Condensers

Each turbine has its own condenser of the "centrifugal jet" type, Fig. 5, with 18-in. injection pump and 20-in. discharge pump mounted on 1 shaft. A Wheeler condenser is used for the smaller unit and Alberger condensers for the 5000-kw. units. To avoid flooding the condenser at high water, a central well is provided and an adjustable gate in the intake tunnel, as the water in the Ohio river is sometimes 28 ft. above the tunnels.

#### Double Flow Turbines

Coming now to the most interesting feature of this plant, the double-flow installation, the following description deals with these particular machines in considerable detail. The double flow principle, as used in these large machines, is a modern development adopted for mechanical reasons. In modern hydraulic work, the double-flow principle is largely employed to avoid end thrust. In small machines, however, the double-flow principle is not so much needed from a mechanical standpoint, and the economy of 2 small machines is not likely to be as good as that of 1 of twice the capacity.

For large machines, above 5000 kw. capacity, the double-flow construction will become standard in all Westinghouse work. For smaller capacities, the single-flow Parsons principle, as before, predominates, and in sizes below 3000 kw., the familiar Westinghouse-Parsons constuction, therefore, remains standard.

#### Elementary Construction

The advantages of the double-flow construction will probably be most clearly understood by first considering the low pressure double-flow turbine shown in Fig. 1. Here we have a turbine of the simplest possible construction, consisting entirely of 2 identical Parsons turbines placed end to end, taking steam at the center and exhausting at both ends. Since the 2 elements are identical, and the steam flows through them in opposite directions, the axial thrust will be exactly the same in both sections; therefore, a perfect steam balance under all conditions of pressure, vacuum and load, is obtained without the use of dummy or balance pistons.

As these low-pressure turbines are designed to utilize all the exhaust steam from a non-condensing reciprocating engine, it is possible to tie the engine and turbine together electrically, thus making the use of a governor on the low-pressure turbine unnecessary. With the exception that, as mentioned, the governor may often be omitted from the low-pressure turbine, it is practically identical with the high-pressure double-flow turbine. In fact, the high-pressure machine is directly evolved from the low-pressure by the simple addition of a high-pressure impulse element mounted at the center of the rotor, this simple element serving in a capacity closely analogous to the high-pressure cylinder of a triple expansion reciprocating engine. Fig. 2 represents the final step in the evolution of the present complete high-pressure machine.

#### Features

Some of the features of the double-flow turbine are: Large reduction in bulk and in weight of individual parts, due to increased speed permissible, which is due to reduced span between bearings. Low pressure section in 2 opposed parts giving axial equi-

librium, and permitting the use of low-pressure blading of moderate length. Cylinder not exposed to high-pressure and high temperature steam, as the maximum pressure encountered is about 75 lb. Relatively large volume per pound of steam at admission to the first Parsons section avoids the use of very short blades otherwise necessary with large diameters. But 1 balance piston is required, and that of moderate diameter. The impulse element is well suited to high-pressure and super-heat and works to reduce the shaft length nearly 50 per cent. Exhaust connections passing through the bed plate are largely reduced due to divided flow.

### General Description

Steam enters the turbine through a flanged opening in the lower half of the casing from which it is piped directly to the nozzle block. For convenience in illustrating the nozzle block, Fig. 2, is shown at the top, whereas, it may be located at any point in the periphery nearest the inlet. Expanding in suitable nozzles, the steam strikes the impulse blades, enters the impulse wheel chamber, and is distributed evenly around the casing so as to enter the intermediate Parsons section of the turbine, all around the rotor.

As in the single-flow turbine, the steam then divides along 2 separate paths, ½ entering the left-hand section of low-pressure Parsons blading, the other passing through the interior of the rotor shell which forms the connecting passage to the remaining low-pressure section of Parsons blading at the right-hand end of the turbine. Discharging from the last rows of low-pressure blading, the steam passes into the exhaust connections and to the condenser in the usual manner.

As the same pressure exists on both sides of the impulse wheel disk, this is not subjected to any end thrust and requires no balancing. The difference of pressure between the inlet and outlet of the Parsons intermediate section, is accurately balanced by a dummy piston of moderate dimensions, located between the impulse wheel and the right-hand low-pressure section. And since the thrusts in the low-pressure sections are in opposite directions and therefore balanced, the entire turbine runs in perfect equilibrium under all conditions of vacuum, pressure and load.

It is, of course, necessary to provide means for accurately fixing the axial position of the rotor, and for this purpose, an adjustment bearing on the right-hand of the shaft is fitted as usual. It consists of a number of collars turned in the shaft, into which fit corresponding brass rings fixed in the adjustment blocks. The upper and lower halves of the adjustment bearing may be moved by means of micrometer screws, as shown, thus permitting the axial position of the rotor to be accurately known at all times.

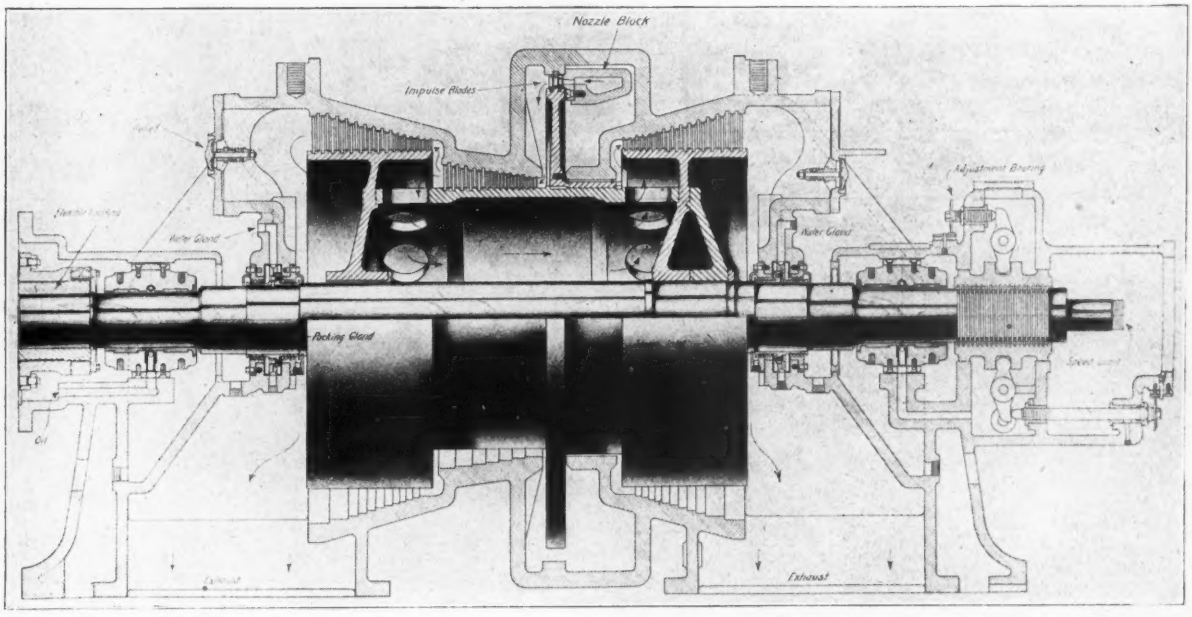


FIG. 2. SECTION OF WESTINGHOUSE IMPULSE AND REACTION DOUBLE-FLOW TURBINE

### Cylinder

All double-flow cylinders are made in 2 parts, the upper and lower halves each being a 1-piece casting. The design is symmetrical throughout, with no longitudinal flanges except those at the center required for bolting the 2 parts together.

Manholes are provided at each end of the cylinder to permit interior examination, and relief valves are fitted in each of the manhole covers to prevent the pressure in the exhaust passages rising to a dangerous point in case of failure of the condensing apparatus and sticking of the atmospheric relief valve.

A Y-connection fitted with 2 corrugated copper expansion joints located below the base of the turbine, connects the separate exhausts to the main exhaust nozzle. This is clearly shown in the longitudinal elevation of the 5000-kw. Brunot Island turbo-generator shown in Fig. 3. By means of these expansion joints, the desired freedom of movement of the turbine casing, due to expansion and contraction, is provided for. It will also be noted that an atmospheric exhaust nozzle opens out of the side of the exhaust Y to permit noncondensing operation.

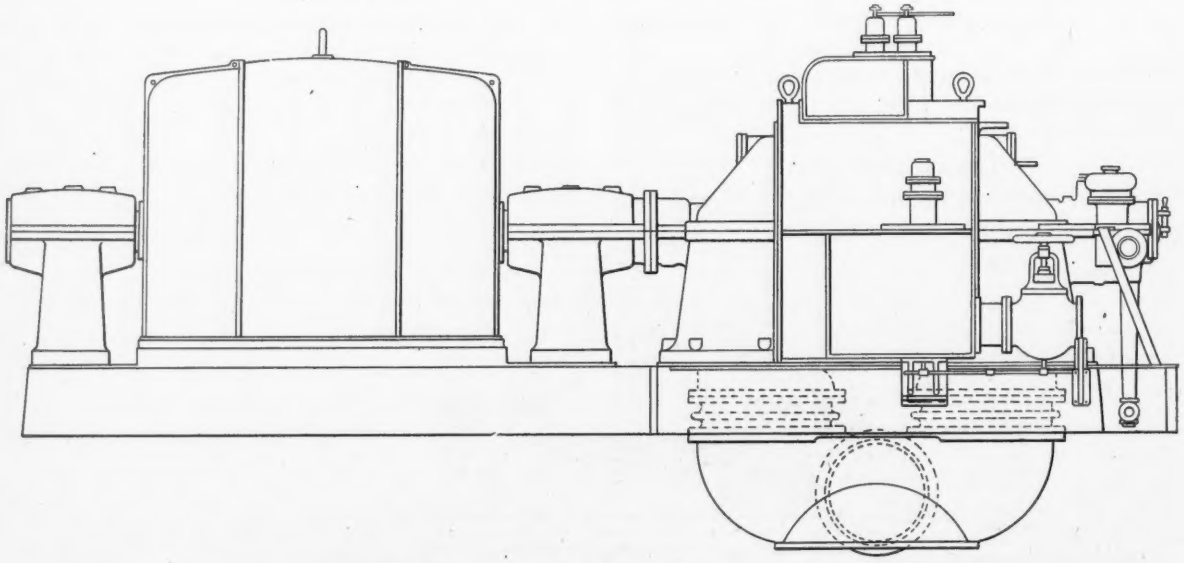

FIG. 3. ELEVATION OF THE BRUNOT ISLAND UNIT

### Rotor

Referring to Fig. 2, it will be seen that the rotor consists of 5 cast steel members mounted on a through shaft. Note that the shaft carries its load at 1/3 the distance from the points of support, thus permitting a lighter shaft than required for distributed loading and practically eliminating the possibility of deflection.

The impulse element consists of a flanged cast steel disk forced on the rotor body with a pressed fit and securely keyed. The flange at the base is grooved and forms the dummy or balance piston for the intermediate Parsons section. A typical arrangement of blading and nozzles is shown in detail, Fig. 4. The nozzle block is an independent casting quite separate from the turbine cylinder, and receiving steam from the governor valve; this restricts high pressure and high temperature to a comparatively small casting, which is free to expand and contract with changes of temperature and may easily be designed with ample strength.

As the steam is not expanded in the impulse element to less than about half of the initial pressure, divergent nozzles are unnecessary and simple straight-sided nozzles are used. The entire nozzle block may be removed in 1 piece, and the construction is such that the nozzle walls may be readily renewed if necessary, at nominal cost, independent of the block.

As practically no differenece of pressure exists on the 2 sides of the element, the area through the bucket increases to provide for the decreasing steam velocity in each rotating wheel. As in all high-pressure impulse turbines, the nozzle blocks cover but a small portion of the rim of the impulse wheel, so that ample space is left around the remaining portion to permit the free circulation of steam in all parts of the impulse wheel chamber before entering the Parsons element.

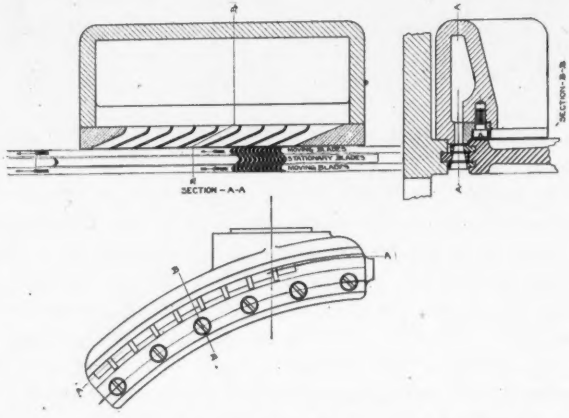


FIG. 4. SECTION OF NOZZLE BLOCK AND BLADING, AND ELEVATION OF NOZZLE PLATE

### Parsons Element

Except for the division of the low-pressure Parsons section, this part of the turbine is identical with the single-flow construction, consisting of a series of rows of moving and stationary blades, increasing in height to allow for the increased volume of the steam.

In the Parsons section the velocities from stage to stage remain practically constant. It will be noted that the diameters of the low-pressure section are chosen so as to permit of the same size blades being used in both intermediate and low-pressure sections, thus simplifying the blading considerably.

### Blading

As there are a number of improvements in the

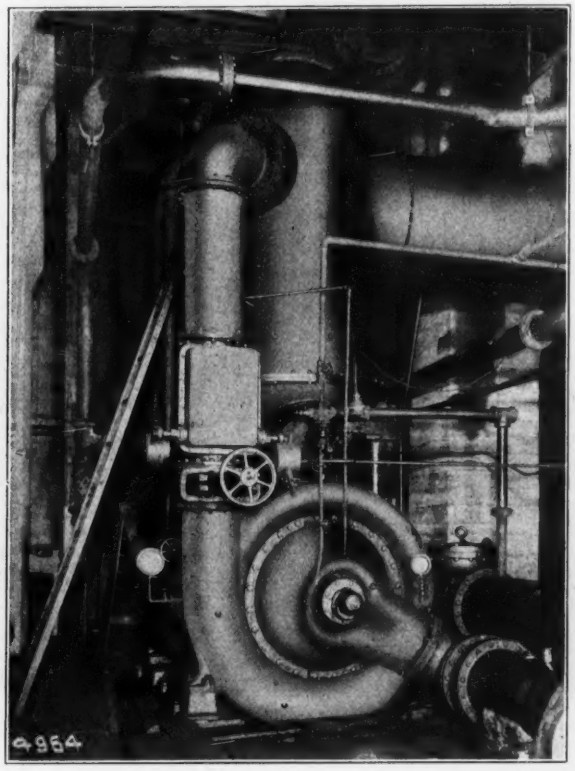

FIG. 5. CENTRIFUGAL-JET CONDENSER UNIT

Westinghouse Parsons blade construction used on both the single-flow and double-flow turbines that have not been previously described, they will be of interest:

No one metal has all the physical characteristics desirable in a blading material. But recently a special, compound metal has been developed, which is used in Westinghouse turbines, known as Monnot, or duplex metal. This consists of a steel core covered with a thin copper sheathing chemically welded to the steel in such perfect manner that the blades may be drawn cold from the original ingot into the required finished section without in any way affecting the bond between the copper and steel.

Experiments have shown that pure copper offers the maximum resistance to chemical corrosion, resulting from bad feed water carried over in the steam during priming, and at the same time the integrity and great strength of the steel core is maintained.

### Packing Glands

A water-sealed gland, shown in Fig. 2, is fitted on each end of the turbine shaft where it passes through the exhaust casings. This packing consists of a small centrifugal pump propeller running in an enclosed chamber to which water is supplied under a head of about 10 ft., which is slightly in excess of the head due to the centrifugal force acting on the water in the impeller blades.

The action of this gland is always to maintain a solid mass of water around the periphery of the impeller, which effectually prevents the entrance of air to the condenser or the escape of steam to atmosphere when running noncondensing.

### Governing

Essentially the same system of governing is used in the double-flow as has become familiar in the single-flow design; namely, the "puff" or "gust" system comprising a constant number of admissions per minute with a variable duration of admission according to the load. This refinement of the purely throttling method, is distinctly different from the principle of governing by adding nozzle after nozzle, all at maximum pressure, as the load increases. Both the "puff" method and that of individual nozzle control, may

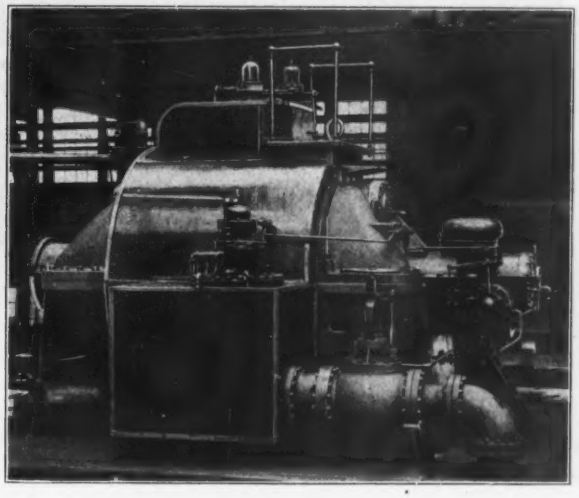

FIG. 6. 5,000-KW. DOUBLE-FLOW TURBINE

properly be regarded as purely mechanical methods of securing a constant-speed prime mover—neither possessing any important thermo-dynamic significance.

For small ranges and with throttle governing, the nozzle and blade areas are reasonably correct through a wide range of load and pressure distribution. For this reason, the impulse section of the Westinghouse turbine expanding, say only 1/5 of the total range, is properly proportioned for a wide range in load and may be governed without resorting to intermediate nozzle control, and without any sacrifice of economy at fractional loads. The type of governor controlling the double-flow turbine, is of the sensitive fly-ball type,

differing only in minor details from the standard governor for single-flow machines. A small relay steam piston does the actual work of moving the turbine valves, thus relieving the governor of practically all work except moving a small pilot valve. For convenience, in synchronizing and distribution of alternating current load, the governor is fitted with a small motor and weight by which the governor spring tension may be controlled from a distance—usually from the switchboard.

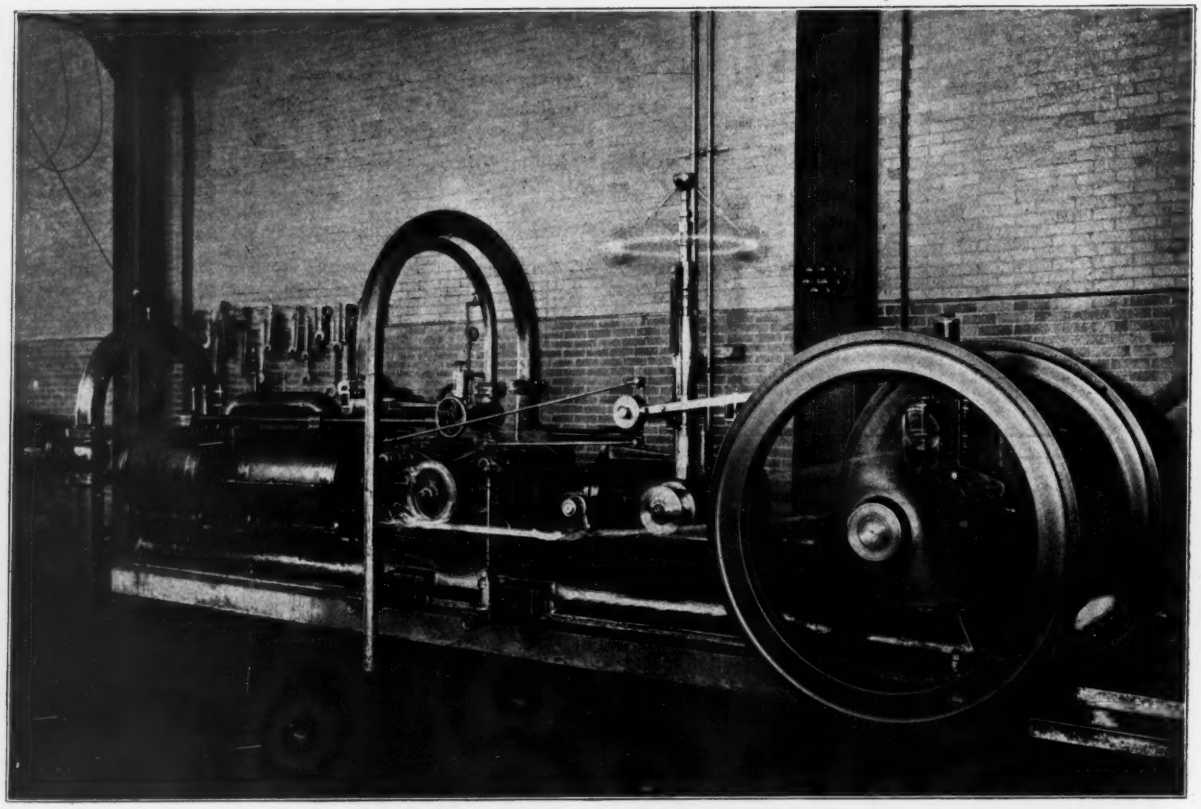

FIG. 7. WHEELER DRY AIR PUMP FOR CONDENSER INSTALLATION

## SETTING A MARKET VALUE ON A WATER-POWER PLANT

The value of such a plant, says Charles T. Main, mill engineer of Boston, varies extremely with different conditions which govern the first cost, and with the character of the work done. The effect of the head, length of dam, length of canal, distance from canal to river, etc., increase or decrease the cost of construction. Much better work is done in some places than in others, which increases the value and decreases the depreciation, so that no general rule can be given to cover all cases. The plant must be considered not alone, but in connection with the privilege, each being dependent upon the other, and each affecting the value of the other.

For the water-wheels themselves, the average life of the wheel is probably about 25 years, while the casing might be allowed to outlive 2 wheels. Iron or steel penstocks, if taken care of, should last probably 100 years, but wooden feeders underground will not last 50 years. Wooden flumes, gates, and racks which are exposed to the weather will last about 20 years. Some wooden dams have lasted a great many years, but they are apt to get washed away in freshets. Stone dams, if properly designed and well built, will last for hundreds of years.

The market value of the wheels would depend somewhat upon their efficiency, independent of their physical conditions; for it might pay to replace them, if water is expensive, by wheels of higher efficiency. The vertical wheels with bevel gears will not produce as much net horsepower per cubic foot of water as the horizontal wheels; and with the horizontal wheels the extra expense and danger of breakage of gears is avoided.

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PATENT HAS BEEN ISSUED to Dr. H. S. Blackmore for a process of converting natural gas into alcohol. The gas, mixed with oxygen or air, is passed over electrically heated gauze so that the hydro-carbons and oxygen combine at a temperature below that at which alcohol burns. The cost of the raw material is about 0.5 to 1 cent a gallon.

# STORAGE BATTERIES AND THEIR OPERATION

By Jacob Glogau

IN POWER plants the storage battery forms one of the principal factors of the satisfactory working of the generating station. If the storage battery is not charged right and proper care taken of it it is a nuisance, because many repairs will have to be made, and a good deal of time lost, but an engineer who takes good care of the storage battery will always find time to look over his machines and allow the battery to do the work of the station while he is doing his other work, thus being a help to all the electrical apparatus in the power house.

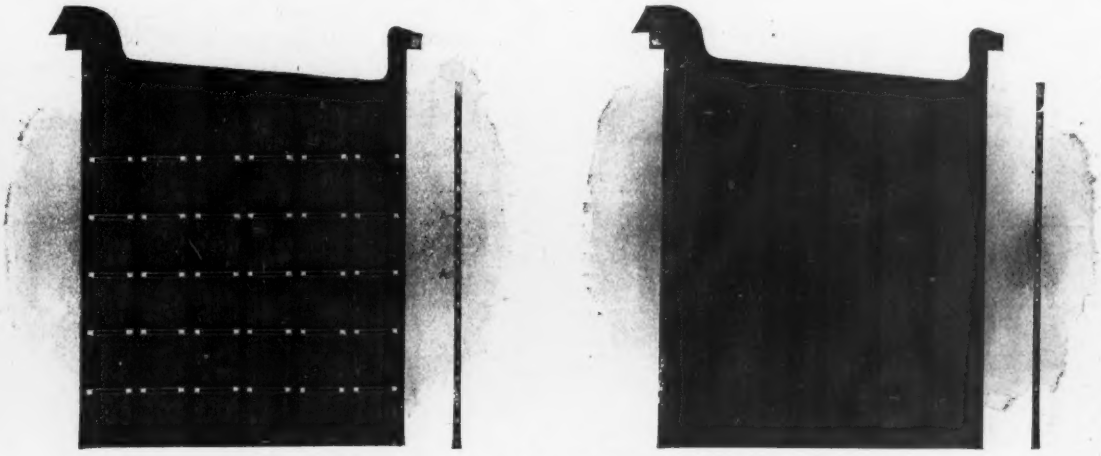

FIG. I. POSITIVE AND NEGATIVE PLATE OF WESTINGHOUSE SS BATTERY

### Charging

In charging the batteries, the current used depends upon the size of the cell and the method of charging. There are three ways of charging, namely: at constant wattage, at constant voltage and at constant current. The prevailing form is by the constant current method, as the constant voltage and wattage are objectionable. If a battery is rated at 2000 ampere-hours at an 8-hour discharge, then the charging current would be $2000 \div 8 = 250$ amperes. This amount can be increased from 10 to 15 per cent at the beginning of the charge but has to be reduced to normal as the charge goes on, on account of the gases which would be given off if the current was kept up at that rate.

There are 3 principal ways of telling when a battery is completely charged: by the color of the plates, by the voltage of the battery, and by the specific gravity. The positive plate will have a chocolate color and the negative will have a slate color when fully charged. The exact time to stop charging is determined by the reading of the voltmeter and the reading of the specific gravity.

A storage battery when new, on normal charge and at a temperature of 70 deg. F. will give about 2.52 volts, and as the battery grows older this value drops about 4 per cent, or 2.40 volts. If the charging is higher than normal, then the voltage of the cell will be larger and vice versa. The specific gravity of the cell does not vary much, and if any variations do take place it is on account of the spraying of the electrolyte during the charge or on account of the sediment which forms at the bottom of the tank.

In regular operation, if the voltage of the battery remains constant for about a quarter of an hour it is safe to assume that the battery has been completely charged.

An instrument which is of great help to the operator of storage batteries is the recording voltmeter, by means of which we can tell when it is time to charge the batteries or when it is time to stop discharging. Practical operation has shown that in order that the battery shall give the best results, the average electromotive force per cell for any discharge should be about 2.09 volts; this is for cells in good condition and will rise in value as the battery grows older.

### Discharging

When discharging cells, practically the same care must be taken as when charging. The principal fact is to know when to cut the battery off and also the rate of discharge. If batteries are excessively discharged the plates will begin to buckle, and cause short circuits, thus ruining the battery.

As the discharge continues the 2 principal guides will be the fall of the specific gravity and the fall in voltage, also the color of the positive plates will change to a yellow brown and the negative plates to a dark slate color.

The specific gravity should never be less than 1.17 and the voltage should not be less than 1.7 volts at the end of the discharge. When the battery has finished discharging it should be charged at once, because, if allowed to stand, the plates will sulphate and cause a lot of trouble.

**Troubles and Remedies.**

The principal troubles are: sulphating; buckling; disintegration; short-circuits.

Sulphating is caused by overdischarging a battery, and letting it stand in that condition, or letting it stand without being overdischarged, but with the electrolyte too strong. The remedy is to remove by scraping the

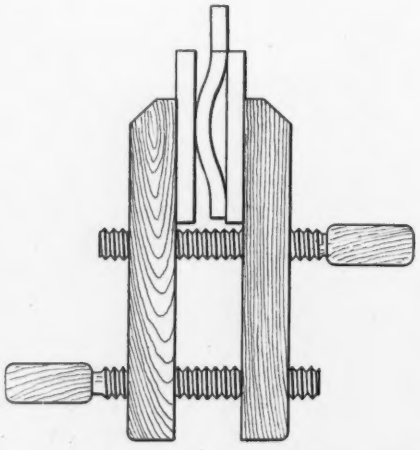

FIG. 2. STRAIGHTENING A BUCKLED PLATE

plates and then charging at a low voltage, for a long period. In this way, by fully charging and only partially discharging, the sulphating is eliminated. Sulphating can also be removed by adding a small quantity of sodium sulphate which decomposes and dissolves the sulphate.

Buckling is caused by the unequal expansion of the plates which is due to the sulphate lodging on the plates, thus preventing action from taking place at that point; and by excessive charging. If the plates are not badly buckled, they can be placed between 2 boards and with a little pressure applied can be straightened out.

Disintegration is caused by sulphating and buckling which forms scale on the plates thus reducing the capacity of the cell. The positive plate suffers from this disease more than the negative, and as the positive plates are expensive the operator must be very careful to prevent this action. To avoid disintegration, do not allow the battery plates to become sulphated or buckled, and attend to all trouble at once.

Short circuits are caused by sediment forming at the bottom of the cell. Raise the plates and place them on glass or wood separators; in small cells the clearance is generally 1 inch and in large cells about 6 inches.

The spray from the battery causes a little trouble in the way of eating up the terminals of the battery. Although many remedies have been tried, the best way of preventing any trouble is to have the storage battery room well ventilated, or a good blower installed. Lead covered copper cables should be used to connect the cells together. The electroyte should be tested at least once a week and if any impurities are present they should be removed.

**Efficiency**

The efficiency of the storage battery is the ratio of the amount of energy discharged to what is put in to bring the battery back to its original condition after a discharge; in general practise the efficiency of a storage battery is about 75 to 80 per cent.

One of the greatest uses of the storage battery is in connection with the central station as an auxiliary to the exciter plant, the storage battery floating on the exciter bus bars as a safeguard against a breakdown. This also renders the use of steam driven exciter units unnecessary.

The battery is also used to take off the peak of the

FIG. 3. CELL MADE BY THE GOULD STORAGE BATTERY CO.

load in both the main and substations and to smooth out the fluctuating loads, and in some cases to carry the whole station load during the periods of small load. This is done a great deal by one traction company, which uses its battery for 4 hours in the early morning to run the cars on the line so that repairs can be made to machinery.

The storage battery must be given proper attention, although one need not be skilled to take care of it; but he must have common sense and be careful and watchful, looking at the battery at least once every day to insure satisfactory performance.

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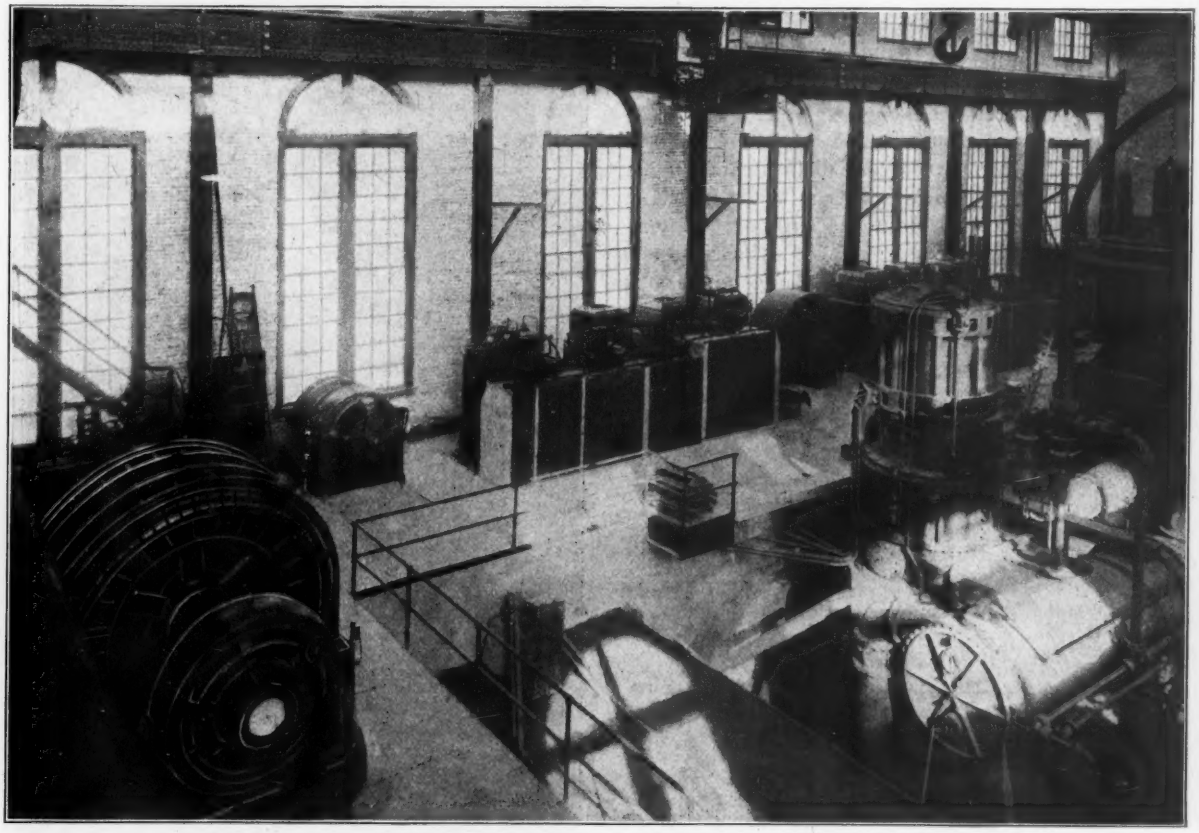
A CUBIC FOOT of cast-iron weighs 450 lbs.

## A TURBINE STATION FOR GENERAL POWER SUPPLY

*(Continued from Page 22)*

boilers has 4000 sq. ft. of heating surface made up of 196 4-in. tubes 18 ft. long and 2 36-in. drums 23 ft. 4 in. long. The boilers are designed for 200 lb. pressure and are run at 180 lb. They are fitted with Consolidated pop safety valves, chain pull gage cocks and chain pull valves to the gage glasses. Space is left for a fourth battery of boilers.



TRANSFORMERS, FREQUENCY CHANGERS AND EXCITERS

The gases are taken care of by 2 stacks, each 8 ft. internal diameter and 180 ft. high above the boiler room floor. They are of self-supporting steel construction, with fire brick lining. The boilers are provided with superheating surface giving 150 deg. of superheat. Steam passes to the superheaters from the steam drums, thence through curved bends which lie crosswise of the boilers to the lengthwise steam mains, which in turn discharge into a steam header located on the boiler room side of the fire wall. All large piping is supported on roller carriers. The main steam header is 14 in. in diameter, the steam pipes leading to it 12 in., and the piping leading to the 2 turbine units 7 and 10 in. respectively.

The stokers are operated by ratchet and gear, the ratchet wheel being driven from an overhead shaft by an eccentric and long rod. This overhead shaft is, in turn, driven by a Kriebel vertical oscillating engine built by Wm. Laycock, of Libertyville, Ill. Besides the main steam header, a pump header is installed having separate connection to the boilers. Recently a bypass has been installed from the pump header to the supply pipe for the smaller turbine, so that in case of necessary repairs to the main steam header the plant can still be kept running.

At the rear of the boilers the blowoff system is carried, each pipe being provided with angle blowoff valve and a Homestead blowoff cock. Blowoff discharge is carried to a surge tank from which the vapor escapes to the roof and the water is discharged to the river.

Feed water is supplied to the boilers by 2 single-cylinder outside packed plunger pumps, 16 by 11 by 20 inches, made by the Dean Steam Pump Co., of Indianapolis. These pumps draw their water from the heater into which the condensed steam from the turbines is discharged. Hancock T-handle valves are used at all points on the feed lines and Crane valves and piping on the steam system.

For supplying the house service, and in case of emergency the fire service, 2 vertical Dean pumps are installed, 10 by 10 by 24 inches, the steam cylinders being at the level of the boiler room floor and the

pump cylinders located in the basement. Each pump is rated at 5000 gal. an hour. They are controlled by Fisher governors and pump to a supply tank which keeps the head on the house system constant.

For heating the feed water, and at the same time utilizing the exhaust from the auxiliary steam apparatus, a Webster Star vacuum heater is installed of the horizontal cylindrical type. The surplus of steam not condensed in the heater escapes to atmosphere by a pipe which runs to the roof and terminates in a 5-in. Swartwout exhaust head. The system is supplied with a full set of gages for indicating pressures at all points, Standard gages being used on the boilers, Ashton gages on most of the auxiliary apparatus and American gages on the gage boards for the turbines, which are located in the engine room. A Bristol recording gage is also installed in the boiler room to keep tab on the pressure in the main steam header. Thermometers of the protected type are installed at those points where it is desirable to know the temperature of the water in heater and condensers, these thermometers being supplied by the Hohmann & Maurer Mfg. Co., Rochester, N. Y. To collect drip from the piping in the boiler house a Crane tilting return trap is installed on the pump header and 2 Youngstown steam traps are provided, 1 at each end of the main steam header.

Although district heating is not a part of the business of the company, it is practised to a moderate extent. Steam from the main header is taken through a Foster Engineering Co.'s reducing valve to an underground pipe which leads to the house of the superintendent of the station, J. H. McKenzie, located near by.

### Turbine Equipment

Two turbo-generating units, consisting of Curtis steam turbines and General Electric generators, are installed, 1 unit of 2000 kilowatts, the other of 1000 capacity. These are standard machines in every way, with the hydraulic method of operating admission valves from the governor, the pressure which operates the hydraulic apparatus being supplied from the step bearing pressure line through reducing valves.

From the turbines the steam passes into condensers made by the Wheeler Condenser & Engineering Co., which are proportioned to maintain an absolute pressure of 2 in. under full load for the generators. To maintain this vacuum it is necessary to supply 4200 gal. of water a minute for the smaller machine and 8400 gal. for the larger. In estimating the requirements of the plant the maximum temperature allowed for the cooling water was 75 degrees. On account of the small volume of water in the Little Calumet River and the slow current, it is found that in the hot days of summer the temperature runs from 79 to 85 deg., so that the vacuum is somewhat lower than would otherwise be the case. Even under these unfavorable conditions the turbines are giving satisfactory account of themselves.

Each condenser is supplied with a Wheeler centrifugal circulating pump driven by a vertical engine with a Knowles wet vacuum pump and with a Wheeler rotative dry vacuum pump. The circulating water is taken from the river through an intake crib which has trash racks of T iron, outside of which are placed screens

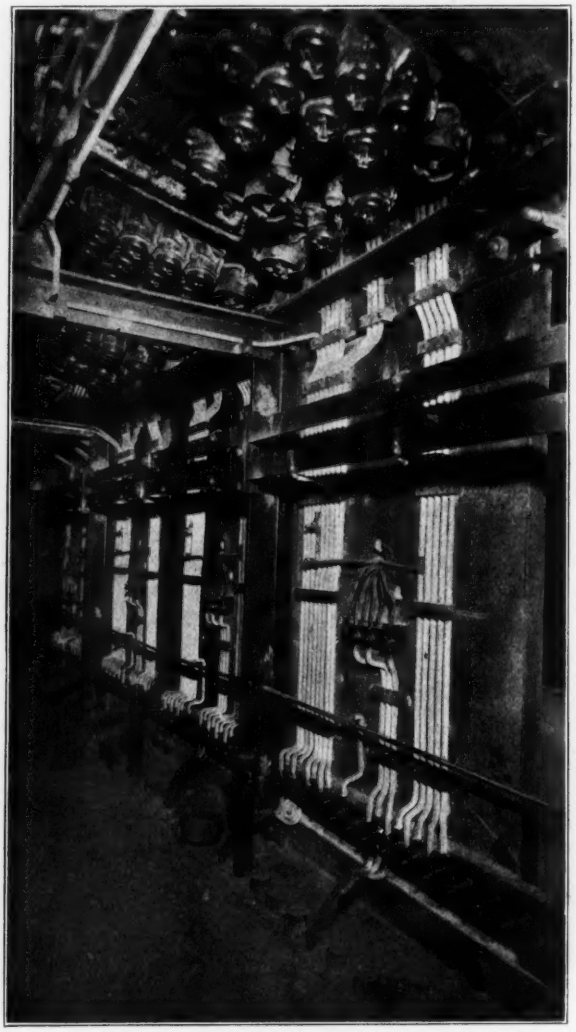


FIG. 7. UNDER SIDE OF BENCH CONTROL BOARD

of wire mesh. It was found that the trash racks were not sufficient to keep out the leaves in autumn, hence a double system of wire screen was introduced, one set of screens lying on the trash racks, the other being placed in vertical grooves inside the trash racks.

The suction pipes from the intake are 24 inches in diameter, leading to the condensers, and the return to the discharge channel is through 20 and 18-in. pipes from the larger and smaller condensers respectively. The condenser surface for the 1000-kw. unit is 4000 sq. ft. and for the 2000-kw. twice that figure.

In case of shutdown of the condensers or failure of the vacuum, steam passes from the larger unit through a 24-in. Crane relief valve to a 28-in. atmos-

pheric exhaust pipe and from the smaller unit through a relief valve to a 14-in. pipe, the 2 pipes leading to a vertical riser which carries the steam to the roof level and discharges it through a Wright Cyclone exhaust head.

### Lubricating System

This is in 3 divisions, the oiling for the step bearings of the turbines, the oiling for auxiliaries and the cylinder oil for steam cylinders. For the step bearings, 3 duplex Worthington pumps are installed, taking their supply from a Turner oil filter and forcing it into a tank at 700 lb. pressure per square inch. This pressure is reduced by passing through baffle compartments to about 200 lb. at the bearing. On the system floats a weighted piston used as an accumulator to keep up the pressure and to furnish the supply for a short time in case the pumps should go out of commission. From the bearings, the oil flows back to the filter to be used over again.

Oil for the upper bearing and for the hydraulic governing system is taken from the 700 lb. supply through a reducing valve and used at about 100 lb. pressure.

The pumps used on this system are of the outside packed plunger type, 7.5 by 2 by 8 in. Two of the pumps are ordinarily used together, the steam being regulated to suit the needs of the turbines. In case of a demand for greater supply, a valve regulated by the height of the accumulator piston automatically opens to speed up the pump. The smaller turbine takes about 6 gal. of oil a minute and the larger turbine 8 gal. in the step bearing.

To supply oil to the pumps and other auxiliaries about the plant gravity tanks are installed near the roof in the boiler room, from which the oil flows through sight-feed oilers to the bearings as required. For the most part, Lunkenheimer multiple feed devices are used. From the bearings the oil is collected in a cast-iron reservoir beneath the condenser pit floor from which it is pumped to a Turner filter in the boiler room basement by means of a Yeomans electric pumping outfit. The catch basin is 5 ft. deep by 24 in. diameter and has in it a float which automatically operates a 2-hp. Jenney motor which drives the pump. The pump is centrifugal and has a capacity of 25 gal. a minute against a head of 20 ft. From the Turner filter the oil is pumped to the overhead gravity tank by 2 Blake duplex pumps, 4 by 2.25 by 4 in., located in the condenser pit.

To supply oil for the cylinders another gravity oil system is used, the tank being filled by the use of water pressure. A New York air brake pump is installed at one side of the condenser pit to furnish air for pressure in the oil tank and for cleaning apparatus about the plant as may be needed. On pumps in the boiler room and about the plant for condensers, etc., sight feed lubricators and force feed pumps are used, the boiler room pumps being fitted with force feed lubricators from the McCune Co., the condensers with Detroit sight feed lubricators, and the step bearing pumps with Hills-McCanna force feed oilers.

### Electric System

All current is generated at 9000 volts and 25 cycles per second. For lighting in the various villages near by transmission is made at 2300 volts after passing current through a frequency changer to give a frequency of 60 cycles. This transmission is 3-phase 4-wire, the voltage between the neutral wire and the outside being 2300 and between 2 wires of the 3-phase 4150. For transmission to Harvey and some of the other more remote towns 10,000 volts is used, although the installation was made for 20,000 volts, and very likely that voltage will be installed when the capacity of the plant has been reached. For the long distance transmission to the Blue Island sub-station, to Moline and Bradley, of the Chicago & Southern Traction Co., current is stepped up from 9000 to 33,000 volts, at which it is transmitted.

Busbars are provided in the basement in separate compartments for the 9000-volt generator current, for the 33,000-volt long distance transmission, and for the 10,000-volt line.

To furnish exciting current 3 sources are provided. On the end of each frequency changer shaft is put a 50-kilowatt 125-volt direct-current machine which may be used either as motor for starting up a frequency changer, or as dynamo for furnishing exciting current for the turbo-generators. There is also a motor-driven exciter set consisting of a Stanley induction motor driving a 70-kw. General Electric generator, and for starting up after a complete shutdown a 50-kw. engine-driven exciter is provided, located in the condenser pit and driven by a tandem-compound marine type engine built by the Stanley G. I. Co.

Oil switches used in connecting generators and transformers to the busbars are of 2 types, 1 for 15,000 volts and 300 amperes, the other for 33,000 volts and 300 amperes. All are motor-operated and controlled from the switchboard in the gallery. All these transformers are air cooled, the blast being furnished by Buffalo Forge Co. fans, driven by induction motors. The air is drawn from the generator room, forced down into air-tight compartments in the basement and flows back through the transformer coils and casing. By this means only 2 fan installations are required instead of 1 fan for each transformer or each bank of transformers, as is often used. Furthermore, the air in the entire basement switch room is frequently changed so that the rooms are always kept dry and cool.

Step-down transformers are used to furnish current at 440 volts for operating the motors about the plant. Convenience in making repairs and changes is secured by a 4-motor traveling crane furnished by the Northern Engineering Co., which travels the length of the turbine room and can pick up any part of the generating or auxiliary equipment. The crane has a lifting capacity of 30 tons with an auxiliary hoist

# THE ACTION OF AMMONIA COMPRESSORS

By Joseph H. Hart

In a recent comparative test an attempt was made to settle various questions about design, construction and operation of two extreme types in ammonia compressors, and a clear understanding of the test in question and the points at issue can only be realized by a thorough comprehension of the action of the ammonia compressor, the difficulties met with, and the 2 attempts at their elimination.

An ammonia compressor is identical in operation with an ordinary air compressor, the fact that ammonia is used instead of air proving of minor significance. Thus the action becomes somewhat simplified. The air is compressed by the direct action of the piston in all ammonia compressors as constructed at present and the action is reciprocating, identical with that of the reciprocating engine. The ammonia during compression, however, has work done on it and becomes hot.

In the initial compression stroke the gas is compressed adiabatically unless a water jacket is used to cool the cylinder. This cooling effect, however, is never complete and during successive strokes the cylinder walls gradually heat up to a definite fixed temperature where the loss in heat becomes equal to the supply from the work done in the compression. This loss is in general two-fold. By maintaining a cold water jacket a large proportion of heat can be carried off here, but if the action of the compressor is rapid, a fresh supply of gas is thrown in on the second stroke before the heat radiation from the previous one is complete.

Under these circumstances the incoming gas on contact with the cylinder walls becomes quite hot and cools them off, perceptibly diminishing the work required of the water jacket. The effect of heating up this incoming gas is not to increase its pressure as long as the inlet valve is open but rather to diminish its density. In some actual cases the cylinder has filled up with gas at the ordinary suction pressure and then become heated so much that its expansion at this pressure has resulted in a back flow through the cylinder of as much as 20 per cent of the total cylinder capacity.

This explains somewhat the necessity of quick valve action required in ammonia compression, but of this, the action is never sufficient to completely prevent this effect and the phenomenon known as cylinder reheating is responsible for a diminution in capacity of the compressor of from 10 to 20 per cent, with an effect in the average compressor half way between this. The fact that the ammonia compressor operates at diminished capacity in regard to quantity of ammonia gas compressed further results in the condition that the refrigerating effect is diminished in like proportion since the latter is directly proportional to the amount of ammonia that passes through the compressor, other things being equal.

Since the initial pressure is in no way diminished by this heating effect, the work required is approximately the same, hence the total result is a diminution in the efficiency of action of the ordinary ammonia or air compressor of approximately 15 per cent due essentially to what is known as cylinder reheating.

Again, the effect of clearance in the action of compression is fairly well known to the average engineer. The air or ammonia compressed to the required condenser pressure and retained in the clearance space is again expanded on the return stroke and cuts down the capacity of the cylinder for a fresh supply of gas. Further, the heating and cooling effects of this clearance gas are such that they tend to diminish efficiency throughout their entire action. The effect of clearance can be summed up briefly as a diminution in the effective cylinder capacity of the machine, together with a further limitation on efficiency equivalent to the insertion of a spring in the crank shaft. These two effiects, notably clearance and cylinder reheating, are responsible for the many variations in ammonia compressor design and operation.

One type of compressor utilizes an oil circulating system in conjunction with the ammonia compressor to eliminate clearance effects and promote maximum cooling of cylinder walls. A certain amount of oil is injected into the cylinder each stroke of the compressor, and on completion, the clearance space is filled with oil instead of ammonia gas under pressure, which on expansion does not affect the cylinder capacity for the next stroke except by the known amount of the clearance space. The oil further tends to alleviate the high temperature effects of the cylinder walls, since it absorbs a portion of the heat of compression and circulates in turn, the object of the system being especially to produce what is equivalent to a water jacket in the interior of the cylinder as well as on the exterior.

This design, while theoretically of great value, is limited in actual practice by several important defects. Thus the oil itself, unless of a very high grade, absorbs a large amount of ammonia gas under pressure and gives this up with decrease in pressure and rise in temperature very much as the absorption machine operates in the evolution of ammonia gas from aqua ammonia. Oil is in reality a sponge for ammonia so that the clearance effect is not completely eliminated and there exist alternate expansions and compressions of the volume of gas given off from this oil, although its effect is theoretically much smaller than that in the simple compressor.

The effect of the oil circulating system on the cylinder reheating condition is not so well known and has always been a subject of contention. The other serious difficulty incident to the operation of an oil circulating system in conjunction with the compressor is the fact that the oil cannot be kept in this part of the system alone. In practise a large quantity of oil, sometimes approximating a barrel of oil and ammonia, can be taken from the ammonia cooler each month, and represents oil which has gone over through the condensers and cooling coils and whose general action is to diminish greatly the effect of the cooling coils. Hence, it can be assumed that this type of compressor requires a somewhat larger ammonia condenser and evaporating system than is required with the simple machine.

Two other methods exist for eliminating the difficulties of ammonia compression. One is based essentially upon design of compressor and valves with very slow speed action and the development of a compressor in which these effects are reduced to their minimum by conscientious attention to design and operation. The other development, is based upon the fact that ammonia passes, in its cycle, through its condensation temperature, and through a portion of its operation is in the form of a saturated vapor with possibilities of condensation and compression at this time, analogous to steam in its operation. Thus we have what is known as dry compression and wet compression respectively.

In dry compression the ammonia vapor is essentially a gas and is similar in its behavior during compression to air in its effects in the ordinary air compressor. Cylinder reheating is very great, the mean effective pressure throughout the stroke is much higher than is necessary, and the clearance effect is at its maximum. A certain definite amount of ammonia, however, passes through the compressor at each stroke and this amount is definitely known and can be relied upon. In the wet compression system, on the other hand, the ammonia gas is compressed in contact with its known liquid; that is, a small amount of ammonia liquid is injected into the compressor, at least theoretically, at the beginning of each stroke.

Thus the ammonia vapor is kept saturated throughout the stroke and the pressure and temperature of the mixture cannot rise beyond that of the liquid until all of the latter is evaporated.

In dry compression, the heat of compression is carried off by water jackets to a great extent but the residue diminishes the capacity of the compressor due to the after heating effects of the cylinder walls. In wet compression the heat of compression is absorbed by re-evaporation of liquid ammonia, and thus the mean effective pressure is raised by an amount due to the gas produced, and the duty of the ammonia condenser is considerably increased. The capacity of the ammonia compressor, however, is a definite known amount per stroke, and as a general thing the compressor can operate at a considerably higher speed with less loss in efficiency than can be done in the dry compression system.

If these 2 types were the only wevelopments the question would be comparatively simple; but all possible variations between absolutely dry compression and absolutely wet compression exist. That is, a portion of the stroke can occur under wet compression conditions, the liquid ammonia injected into the system can become entirely evaporated before the stroke is complete, and the remainder of the cycle may be completed under dry operating conditions. Again, saturated ammonia vapor only may be injected instead of a mixture of ammonia vapor and liquid, and under these conditions a result analogous to wet compression exists for a small portion of the stroke. It is this complexity and possible variation through all the process that complicates the development of a satisfactory and efficient method of operation.

In actual operation, wet compression is attained by the flooded system of ammonia cooling and by carrying the frost back to the compressor. Thus in actual operation all engineers have various devices and rules for attaining best results in the operation of a refrigerating plant. Many engineers carry the frost completely over the compressor, keeping the gas during the entire period of compression at a temperature below 32 deg., thus eliminating all the possible utility of a water jacket and wasting a tremendous amount of liquid ammonia by circulation without evaporization in the cooler, thus diminishing the refrigerating effect of the process. In the frost-covered ammonia compressor, a certain amount of ammonia liquid is evaporated each stroke, and in the extreme case this may exactly equal the excess ammonia which is condensed in the ammonia condenser.

Under these circumstances little or no refrigeration would be produced and the object of all operating engineers should be essentially, to increase the ammonia capacity of the compressor to its maximum amount per stroke and to do this at the lowest possible temperature attainable, since the latter means a diminution in the mean effective pressure and a consequent lowering of the steam consumption.

Some operating engineers on the other hand, carry the frost back to the inlet valve of the compressor, and never allow it to extend beyond this or to fall back to any great extent and this is the generally accepted condition for maximum efficiency of operation in the majority of cases. Whether this is so or not is largely a matter of opinion, since experts apparently disagree in regard to the theoretical efficiency of the process, or rather in regard to the theoretical conditions of greatest efficiency. The fact that in the test mentioned the wet compression machine showed an efficiency fully 10 per cent greater than that of the other type seems to warrant the belief in the best efficiency of that system.

The actual operating conditions for best efficiency under wet compression conditions have not, however, been definitely determined. The exact extent to which to carry the frost back, which is the superficial indicator of wet compression, or the exact temperature and pressure under which to operate for a given condensor water temperature, are unknown and the best speeds of operation for given conditions are equally a matter to be determined by the average engineer for himself in individual cases. That attempts at comparison under different conditions should be made even in the smallest plant is an unnecessary statement and comparisons can be readily obtained in a simple manner if any kind of a record is kept at all from day to day in the operation of the plant.

The fact that the method of operation still remains a bone of contention among manufacturers themselves is proof that the question is not entirely satisfied and that discrimination can be shown by the average operating engineer in his method of operating a machine.

## SAVING OUR FUEL

Speaking before the Annual Convention of Smoke Inspectors at Cleveland, D. T. Randall of the U. S. Geological Survey Fuel-Testing Plant emphasized our present waste of fuel, stating that less than 5 per cent of its value is converted into heat, light and power, or in pulling a train.

Nearly 2,000,000 hp. is allowed to escape from the blast furnace stacks and a great amount from coke ovens.

To try to remedy this condition is the object of the Fuel Testing Division, and a commission with members from the great engineering societies and from government departments has been appointed as an advisory board. The work of the Plant is divided into analysing and testing coal; determining the amount, properties and best ways of utilizing fuels; finding means to use low grade fuels; finding means to abate smoke with resulting increased efficiency.

A saving of only 1 per cent in the fuel bill of the country would amount to nearly $20,000,000.

As a result of investigations, most of the coal used by the government during the coming year will be paid for on a heat value basis as determined by the calorimeter, one of the largest lots being 400,000 tons for use at Panama.

It has been shown that by the use of proper furnaces, practically all coals can be burned without smoke, and that many fuels considered too low grade for boiler furnaces can be used successfully in the gas producer, the lowest grade lignites from North Dakota developing as much power per pound as do the best West Virginia bituminious coals when used in a steam boiler with simple non-condensing engine.

"WHATEVER YOU DO, do with all your might, and regard nothing as too small to be done the best that you know how."

## A SCHEME TO PREVENT FREEZING BACK.

BY A. MINER

This was a case where there wasn't sufficient refrigerating piping to give the required cooling surface to keep the temperature down where it was wanted. The result was a tendency to force the coils by feeding too fast through the expansion valve, in consequence of which liquid ammonia was carried into the compressor resulting in a freeze back. This was annoying, expensive and dangerous.

When the packing became frozen, ammonia would leak from the stuffing box, and on 2 occasions, when it was screwed up while cold and not let out again

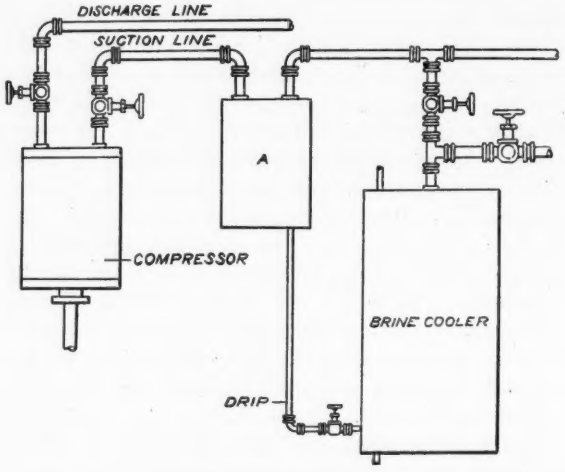



FIG. I. SEPARATOR CONNECTED TO SUCTION LINE

when the freezing back ceased, it stripped the threads of the bolts, and blew out the gland and packing, This filled the room with ammonia, driving everyone from the engine room. There was a loss of time, temperatures and ammonia, which amounted to several hundred dollars.

The installation consisted of 1 125-ton York compression, and 1 50-ton Carbondale absorption machine. There was an auxiliary brine cooler installed for use with the absorption machine which was seldom used.

A separator was placed at A, in the suction line to the compressor, to remove the liquid ammonia, and prevent it from getting into the compressor, with the resulting freeze back. The drip from the separator was piped into the auxiliary brine cooler of the absorption machine, and brine was pumped through the cooler coils.

The scheme was a success. It prevented those annoying freezebacks, gave the operating engineers more leeway, and also gave an added check on refrigeration from the brine cooler which would otherwise be lost.

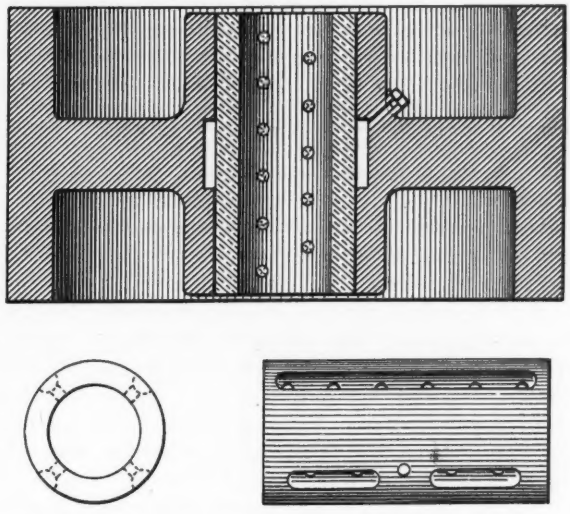
A MINER'S INCH is a measure of flow of water and is an opening 1 in. square in a plank 2 in. thick under a head of 6 in. of water at the upper edge of the opening.

## REPAIR KINKS

### Self Oiling Pulley

As there has been considerable discussion in the different power papers about loose pulleys and their lubrication I send you this sketch hoping that it may be of value to some of the craft.

I took a cast-iron pulley, 12-in. diameter and 6-in. face with 2 7/16-in. bore.



METHOD OF MAKING A LOOSE PULLEY SELF-OILING

I had this bore dressed and a chamber cut in the center, 0.5 in. deep and 1.5 in. wide and tapped a hole into it for a 0.25-in. plug for filling.

I then had a brass bushing made to fit the shaft, 1-7/16 in., and dressed to a driving fit for the pulley bore. Holes were tapped, staggered in the bushing and threaded with 0.25-in. pipe tap. Oak plugs turned to size, which had been soaked in oil for a couple of weeks, were then screwed into the holes and extended through on the inside; the bushing was put in the lathe and plugs turned down flush inside and outside. Grooves 0.5 in. wide and 3/16 in. deep were then cut in the bushing from the outside plugs to the oil chamber in the hub.

The bushing was then keyed in the hub of the pulley, the shaft oiled where pulley rode and the pulley slipped on.

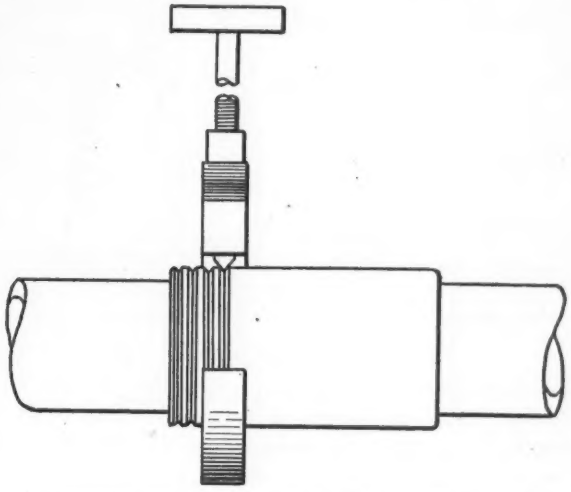
I filled this oil chamber once in 6 to 8 weeks and it never ran hot nor threw oil and it was severely tested at that.

While the first cost makes it prohibitive for ordinary places, there are many places where efficient service and no oil splashing around makes it an extremely desirable device. A. E. McKenzie.

### Leaky Pipes

To avoid expense for coupling or other material and to save time, which is always limited when pressure is on a leaky pipe, I have used a method which in a number of cases has held permanently, and considerable time and some outlay of expense for coupling, etc.

This consists of swaging the coupling on the pipe about the threads, and can be done very well with an ordinary pipe cutter of the hand power type. The cutter should be placed as near the end of the coupling as it will work satisfactorily and operated the same as in cutting pipe until the cutter has run to a depth of perhaps 1/16 in. About 3 or 4 different positions as near each other as possible will generally crimp or swage the coupling to a tight fitting joint. The objection to this method is generally advanced that it weakens the joint by cutting the coupling, but when the amount of metal still left is compared with



METHOD OF TIGHTENING LEAKY PIPE JOINTS AT COUPLINGS

that left in the pipe at the base of the thread the danger as will be seen is slight. G. G. McV.

### Cleaning Paint on Engnies.

Use a solution of 1 gal. water, 4 oz. borax and 0.5 pt. lard oil stirred into a perfect emulsion. Apply to the painted surface with a brush and let stand a little while but not to become dry. Rub with clean waste. If it does not cut the grease, add more borax.—English Mechanic.

ABOUT $100,000 BONUS will be awarded Allis-Chalmers Co. by the Sanitary District of Chicago on a contract for 2 screw pumping engines installed in the 39th St. Pumping Station, which, with 4 centrifugal pumping units built and installed there by the same company, represent an aggregate maximum capacity of 2,160,000,000 gallons of water and sewage every 24 hours. The official test shows a duty of 145,000,000 foot-pounds, while the contract calls for 95,000,000 foot-pounds, and a bonus of $1,000 was offered for every 1,000,000 foot-pounds in excess of the contract figure.

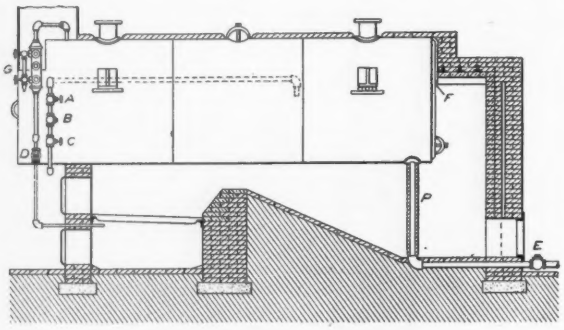
# LETTERS FROM ENGINEERS

**Send us descriptions of ways of doing new things, and new ways of doing old things. Rough pencil sketches and letters are all right; we will fix them up for the printer. All accepted contributions will be paid for when published.**

### Corrected Boiler Setting

Boiler Setting Precautions is the subject of a letter by T. G. R., on page 51, in the July issue of Practical Engineer.

As the result of a misunderstanding, the draftsman introduced several errors, which did not appear in the sektch submitted by T. G. R.




CORRECTED BOILER SETTING

Herewith a correct sketch is presented, as it accompanied the letter referred to. Editors.

### Removing Side Slap in Brasses

Editor Practical Engineer:

In the case of the Corliss engine side slap cured by W. S. on page 32 of the April issue, if he would like to cure the side slap trouble permanently, I would advise him to proceed as follows:

Take off the crank pin boxes and strap and block up the connecting rod in an easy position to be moved sideways. Next strike a center line on the connecting rod equidistant to the vertical face on each side. Strike a line midway between the ends of the crankpin; key up the crosshead boxes on the pin as tight as possible without springing any of the parts out of shape, keeping the same amount of play on each side of the crosshead pin boxes. This can be done by using a feeler or thickness gauge between the faces of the boxes and the boss at each end of the crosshead pin.

Now test the alignment at the crank end of the connecting rod, by placing a straight edge on the top face of the connecting rod true with the center line. Should it not coincide with the line on the crankpin, it will be necessary to scrape the crosshead boxes enough to bring the straight edge over to the center line on the crankpin.

This should be done by scraping one end of the bore of the front box, and the opposite end of the bore of the back box, being careful to keep a good bearing as near the full length of the boxes as possible.

If, however, the crank end of the connecting rod is in correct alignment, put on the crankpin boxes and strap and key them up the same as the crosshead. Take off the crosshead boxes and proceed the same as before.

If the center line on the crosshead end of the rod does not prove to be in correct alignment, it will be necessary to scrape the crankpin boxes, using the method described for the crosshead boxes. Should the crosshead and the crankends of the rod appear to be correct, there is but one remedy to cure the trouble.

Remove the piston, crosshead and the connecting rod. Run a fine line (piano wire preferred) through the cylinder and past the crankpin, in the usual way to line up, then set the line central to the back counterbore and central in the stuffing box.

The shortest method best adapted to the type of engine should be used to place the part found out of line in correct alignment.

To the average reader this may seem a long way around, but I have found it from long experience to be the shortest way to a good job.

On page 51 of the June issue, E. G. Haddix suggests soldering a piece of brass on the face of the boxes, in place of W. S.'s pegs; neither of these is good practice.

Mr. Haddix also describes a method of making a tight fit of the brasses in the strap, by cutting the top face of the boxes with a dull chisel to expand the metal. This job could be done by planing 1/16 in. off the top face, and sweating a piece of sheet brass on the planed surface, then refitting the boxes to the strap.

This plan is in consideration of the strap being a good fit on the rod.

Should the strap not be a good fit on the rod, it will be necessary to heat the strap, close it in, and refit it to the rod, thus omitting the job of sweating the liners on top of the boxes, as the boxes should be fitted to the strap before the rod faces are filed true, to fit in the end of the strap. W. M.

### One Way Out of a Shut Down

Editor Practical Engineer:

Recently the writer was called upon to babbitt a

crank-pin box on a twin vertical engine, one side of which was giving an unusual amount of trouble by breaking the boxes or working loose every 24 hours, and letting everyone in the town know when it was at work.

As a result, the maker was cussed in many strange and original cusses for ever putting such a poorly designed machine on the market, and to tell the truth,

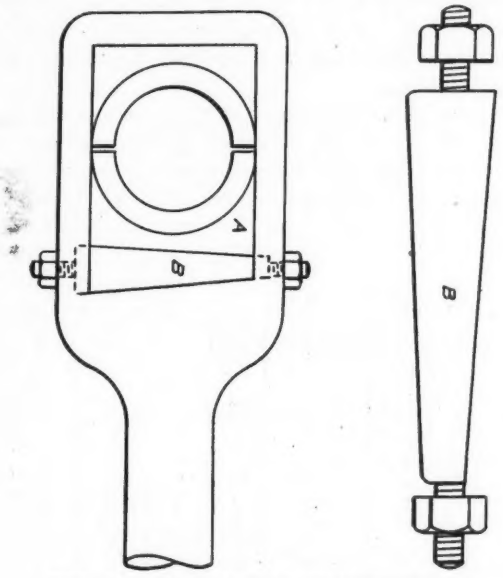



FIG. 1. CRANK END OF CONNECTING ROD
FIG. 2. TAKE UP BOLT

the writer had put in a few, and not without reason.

The bodies of these boxes were of cast-iron, with a taper pin and screw takeup, the side next the pin being not over 3/16 in. thick, just enough to hold the babbit. The connecting-rod was of the closed end or solid type.

Well, we had started the season with new boxes, and had been running about a month when it was necessary to babbitt them over. When the writer took this box out to clean and re-babbitt it, behold it was in 4 pieces, and not a spare box on hand, and none within 500 miles. That box had to be replaced within 8 hr. or 75 men would have to loaf and a busy mill lie idle at least 2 days.

The first thing that came to the writer's mind was to make a small form around half of the mandrel used for babbitting, and cast a box in that of babbitt metal, which could have been done, and preparations were under way, when the engineer (a Maine Yankee who never said much) proposed that we back the takeup pin out to its lowest point and plug the holes and sides of the box recess; then pour the metal in to fill, and in this way make sure of a good fit. The advice seemed good; this is how we went at it.

Fig. 1 represents the crank end of the connecting rod, which is all one piece, the top part of A being babbitted to make half the box, and the takeup B in its proper place, and the space A to be filled. B is merely a round bolt, planed flat and tapered on one side, and threads on each end for adjustment, like Fig. 2.

One side of A, Fig. 1, was partly closed by the crank; this and the holes not filled by the screw end of the takeup pin were filled with yellow soap to prevent the metal from running out. The front side was covered up as high as the center of the crank pin A, Fig. 1, with a piece of 15-in. soft pine plank, out of which a place had been gouged to pour the metal through into the recess. This was clamped into place and the joints filled with soap, then the metal poured in. Then the board was taken off and the metal trimmed flush with the end of the pin, and the guard cap replaced. All was in readiness for a start the next morning.

It has been in use nearly 3 weeks now and bids fair to go the rest of the season without further trouble. W. E. Chandler.

## Packing Condenser Tubes

Editor Practical Engineer:

Herewith I send you a contribution on condenser tube packing, which I think will interest your readers. The customary method of expanding tubes in the condenser heads always means delay in the renewal of defective tubes.

A much simpler plan is the application of rubber rings into conical recessed holes in the heads for get-

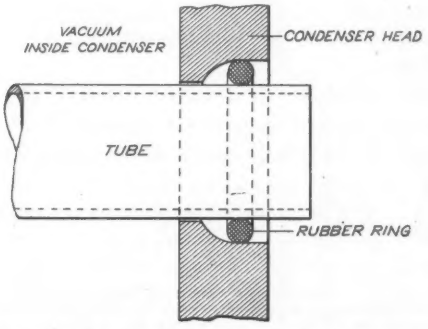



FIG. 1. SUGGESTED METHOD OF PACKING SURFACE CONDENSER TUBES

ting tight joints, as shown in the accompanying sketch. This joint also allows a free expansion of the tube, and the rubber insulation interrupts all the destructive galvanic currents usually giving rise to many of the troubles with condenser tubes.

Further, as without exception surface condensers require a thorough cleaning of the cooling surfaces, inside as well as outside the tube, it is a comparatively easy operation to remove and insert tubes with this style of packing. U. Peters.

## A Useful Jack

Editor Practical Engineer:

Herewith I send drawings and description of a small "Jack," which was recently built in the shop

where I am employed. For general use about a plant or shop, it is unequalled by anything that can be made from bar iron, with only blacksmith and drill press at hand. Fig. 1 shows the jack complete.

The base is made of 2 pieces of 1 by 1 by ¼ in. angle iron 6 9/16 in. long. The 2 sides are placed back

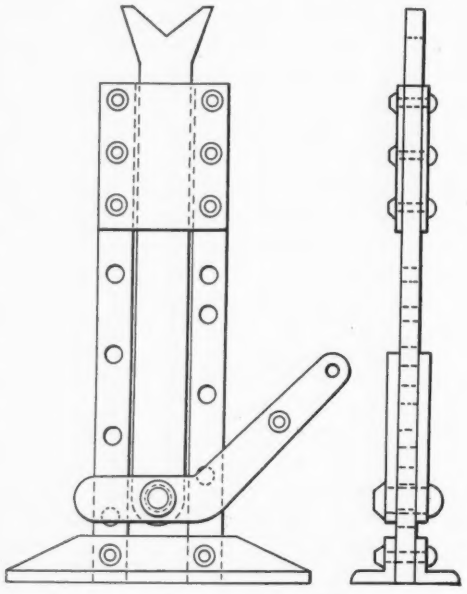


FIG. 1. THE JACK COMPLETE

to back and cut off, running out beveled at the end as shown.

Holes ¼ in. are drilled for riveting to the uprights, 2 1-16 in. center to center and ⅝ in. from the bottom. Two pieces of iron ⅜ in. by ¾ in. iron, 10⅞ in. long

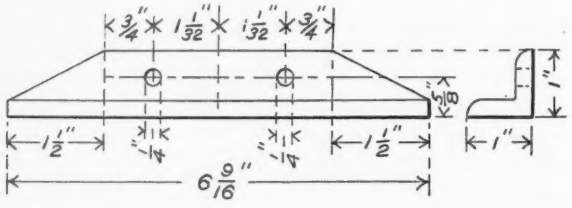



FIG. 2. DETAIL OF THE BASE

are drilled for upright sides as shown in Fig. 3. The 3 top holes are for rivets, supporting a piece of sheet copper 1⅛ in. by 2 13/16 in. by 3 in., shown in Fig. 5.

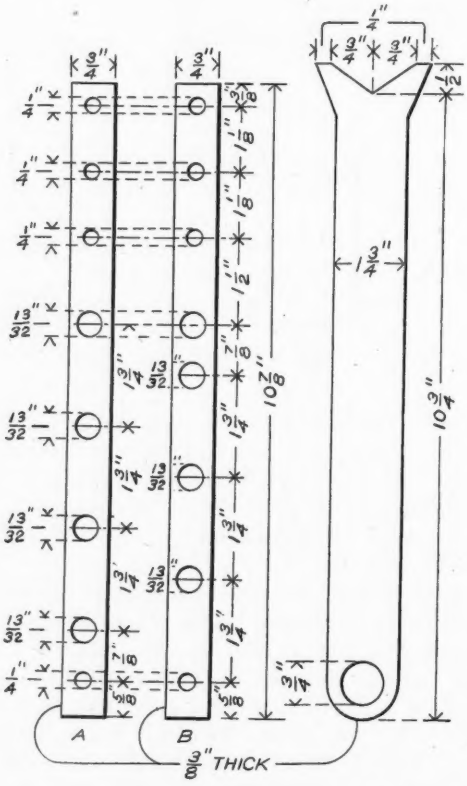
Two pieces like the above are riveted up with the 2 ⅜ by ¾ in. bars, between, and the lower ends of the bars riveted between the 1 by 1 in. angles. The center holes in the copper plate should be left open to receive 2 cotters to hang leather straps.

The jack bar is made of ⅜ by ¼ in. bar iron with the upper end opened as per sketch. The 2 curved pieces shown in Fig. 6, are made up with a short piece of pipe 7-16 in. long between them, and a ⅜ in. cap screw running through the pipe, which should be an easy fit over the screw. This bushing goes into the ¾ in. hole in the end of the jack bar. The cap screw is set up tight on the pieces and the bushing is clamped tight.

The jack bar should be filed down a trifle under ⅜ in. thickness, so that it will slide freely between the copper plates, and allow the lifting bar to swing on the bushing and not bind.

A pipe nipple 7-16 in. long, and large enough to take a ¼ in. rivet, should be riveted between the lifter bar at the ¼-in. hole, which is 2⅜ in. above the ⅜-in. cap screw.

The handle shown in Fig. 7, is made from ⅜ by ¾-in. iron. A notch is sawed in the end, and filed out to fit snug over a small pipe bushing. Figures 2, 3, 4, 5, 6, 7 give the details.




FIGS 3 AND 4. DETAILS OF UPRIGHTS AND JACK BAR

The operation of the jack is as follows:

The handle is inserted, and the cotter pushed through the ¼-in. hole and slot and tightened against the pipe bushing. Two cotters fitting nicely in the 23-32 in. hole are hung on short pieces of leather from the center holes in the copper plate. One of these cotters is pushed through into the hole in the uprights closest to the lower side of the lifter bar, and the handle raised or lowered as the case may require, using a cotter as a fulcrum, raising jack bar and load.

When raised sufficiently to expose another hole,

a cotter pin is inserted, the handle raised and released of the load, another cotter inserted in the higher hole and load raised by the handle as before.

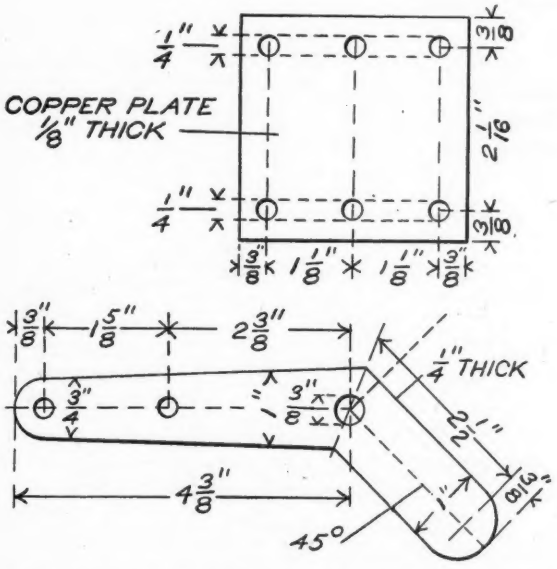
The jack made to the dimensions given will safely lift 1000 lb. and give a vertical lift of about 6 in.

Chas. M. Green.

### Bulge in a Boiler

Editor Practical Engineer:

I notice in the June Issue of the Practical Engineer




FIGS. 5 AND 6. COPPER PLATE AND DETAIL OF LIFTER

that Gus A. Janicke requests some one of the readers to state the cause of the bulge in the boiler he shows in his sketch. He gives no particulars in regard to the condition of the steam gauge, pop valve and whether they were kept in good working condition. Examining into the cause of the bulge, it may be he had 150 lb. pressure on instead of 50 lb. as the gauge would show. The boiler may have been overheated due to low water; or the water which was used caused a heavy deposit. The boiler may not have been cleaned out since it was first put in service. The fire may have been fiercely urged, and the water driven from the surface. As the result the life has been entirely burned out of the metal, thereby weakening it.

Internal corrosion presents itself in various forms, each having a peculiar character of its own. Though seldom strongly marked these are designated as uniform corrosion, wasting, pitting, honey-combing, and grooving. Any of the above conditions will do the trick.

G. O'Brien.

Editor Practical Engineer:

In the June issue of the Practical Engineer, Mr. Janicke wishes to know what caused the furnace of his vertical boiler to bulge. It is impossible to tell just what caused the bulge, without making a personal inspection of the boiler, as the causes for such accidents are numerous.

The waterleg of the boiler may be filled with mud and scale at that point. This would prevent the water from getting to the plate, which would cause it to become overheated, and the steam pressure would push the plate out, sometimes stripping the staybolts in the plates.

Often the staybolts become broken, but seldom in a boiler of that size. These bolts always break next to the outside plate. The writer repaired a small vertical boiler a short time ago, that was bulged badly.

The engineer started his fire leaving the valve at the bottom of his waterglass closed after packing it. Of course the weakest point let go. This was the furnace, as the plates got red hot and the pressure forced the plate inward.

First I examined the plate for cracks and to see if the stretching of the metal had left it too thin. Finding the plate all right, I drilled out the old bolts,

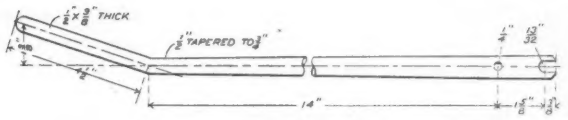


FIG. 7. DETAIL OF HANDLE

putting in a larger bolt, also 1 between the others as the bolts were pitched 9 in.

I would advise Mr. Janicke to make a thorough examination of the staybolts and the water space in the leg of his boiler. These are only a few of the many causes the writer has found in 15 years of nothing but repair work as outside foreman for one of the largest boiler manufacturers in New England.

Geo. A. Fidler.

### A Handy Scale Remover

Editor Practical Engineer:

I enclose a sketch of a handy little device which I made to knock the scale off tubes in my boiler. The

FIG. I. VIEW OF SCALE REMOVER

boilers are of the return tubular type, with tubes 4 in. in diameter.

After passing the cleaner through the tubes, I got 400 lb. of scale out of the 2 boilers.

The blacksmith made the tee, and the pipe was obtained from the scrap pile. Any engineer can make one, and save fuel by its use.

To operate, you have to work the handle with all

possible dispatch, and a sharp blow can be obtained.

W. S. Hudgins.

This is presented for the consideration of our readers, but with some doubt as to the thoroughness of the cleaning which it would give.—Editors.

### Why Does Engine Pound?

I have charge of an engine that has given me considerable trouble. It doesn't get hot, but pounds on both ends. The engine is a simple noncondensing, 18 by 42-in., with speed of 100 r. p. m., and supplied with 100-lb. steam pressure. The engine runs quieter with

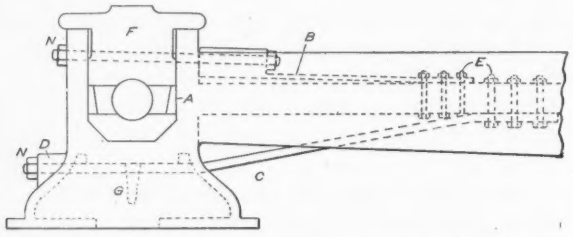



FIG. 1. SIDE VIEW OF BRACED ENGINE FRAME

late cutoff when carrying heavy load, such as is shown in Fig. 2. I would like to hear from other engineers as to the trouble with the engine. A. R. M.

### Bracing an Engine Frame. Bushing a Pump

Editor Practical Engineer:

Some time ago, a crack was discovered in the main bearing of a large Corliss engine, and a me-

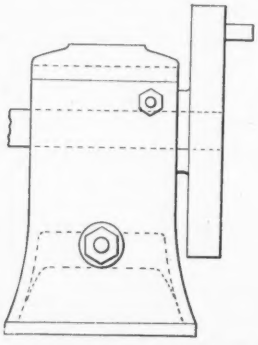


FIG. 2. END VIEW OF BRACED ENGINE FRAME

chanical engineer on being consulted recommended the following method of repair:

The main bearing and the frame were cast in one piece, and the belt ran forward. Figure 1 is the sketch of frame and the bearing; the crack is at A. A hole was drilled through the bearing, just above the shaft, and a 2¾ in. bolt inserted, in the manner shown. The other end of the bolt went through the brace B. Another hole was drilled near the bottom through the web G, and another brace, made of 2¾ in. round iron flattened at the end and threaded at the other, was secured by the nut tightening on the washer D. The other end being bolted to the frame.

The upper brace was shorter, so the bolts through the frame are ahead of those in brace C. The bolts are shown at E. The nuts N-N, were tightened enough to give the braces considerable tension. A channel had to be cut through the cap F, so it could be removed or adjusted without interfering with the brace.

In Fig. 2 the position of the braces is shown, the upper one being placed near the crank side and the lower one in the center. The washer D is of cast iron, a pattern having been made conforming to the outlines of the bearing. Holes for the bolts E were reamed through the braces and the frame when the braces were in place.

### Pump Repair

Some time ago, it was decided to rebore the pump barrels of a large pump. They were found to be worn about a quarter of an inch larger in the center than at the ends, and the leakage was too great for them to

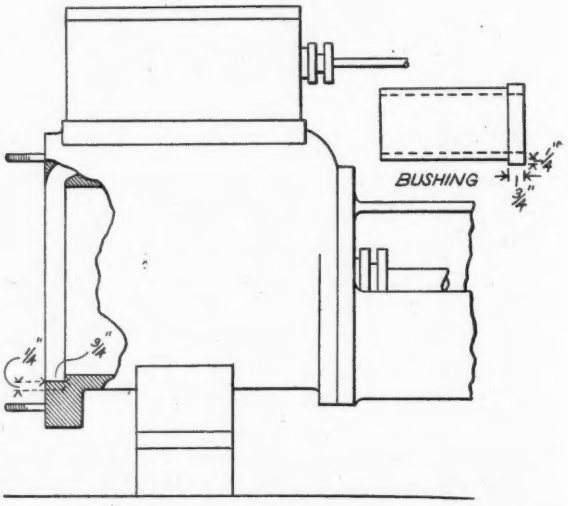



FIG. 3. METHOD OF BORING FOR BUSHING AND BUSHING USED ON PUMP REPAIR

be run with economy. The first cut through revealed some bad cracks, which had not shown up before.

After consultation, it was thought best to bush the pump cylinder with a cast iron bushing. A short counterbore, about ¾-in. long, and ¼-in. larger in diameter than the pump bore, was bored at the upper end. A bushing was made having a shoulder on one end to fit that counterbore. A coating of graphite and oil was given the bushing, and it was pressed in place with a jack. Near the lower end, half-inch pipe tap threads were cut through the holes made in the bushing and pump wall, and plugs screwed in, making a tight fit. The boring bar was then replaced, and a finishing cut taken through the bushing.

A second pump on being bored developed several sand holes in the casting, so this also was bushed in the same manner. The pumps were 20 by 30 in. of the old Holly quadruplex type. Power for the boring bar was furnished by a small rotary engine.

E. G. Haddix.

### Engine-Room Perseverance

Editor Practical Engineer:

That the average engineer meets with a great deal of trouble which would disappear if he would use a little perseverance and ingenuity goes without saying.

Little troubles, that loom up like sand hills on a Michigan shore, are in reality mere trifles when we come to reason them out and face them with dogged determination.

There is no trouble in an engine room without a reason for it and the real trouble is to find the reason for an awkward condition.

As an illustration, the writer calls to mind the case of a Worthington duplex pump that gave an exhibition of total depravity. One side of the pump worked splendidly, while the other side gave quick, short strokes which showed conclusively that little

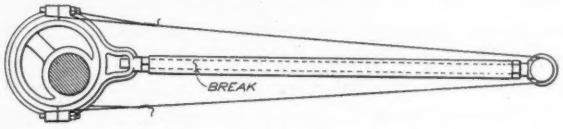



FIG. I. ECCENTRIC ROD REPAIR

work was being done. The stuffing boxes were repacked, the plungers examined, the valves were gone over and everything found to be in proper working condition.

True, the water being pumped into the boiler was very hot and turning cold water into the pump would relieve the situation for a time. Then the kangaroo jump would return and take up its abode just as if rent was being paid in advance.

Why this disgraceful proceeding should continue on one side of the pump, when its twin brother across the way was behaving like a faithful servant was puzzling to say the least.

After 3 weeks of hard thinking detective work and perseverance, the bonnet of the discharge chamber was removed for the third time and the valves again carefully gone over, when it was noted that one of the valve guards was screwed down slightly further than the others. This guard was removed, as was the one on the opposite side, and their places reversed. The bonnet was replaced, the pump started up and lo! the jumping action was removed to the other side; the trouble had been located. The guard did not allow the valve to open enough. The cranky guard was again removed. The two top threads were battered down with a hammer, and the guard replaced. The pump was started off as good natured as a girl going to an ice cream parlor.

So much for perseverance; now for a case of ingenuity.

An engineer friend had the misfortune to have an eccentric rod break at a time when it was highly important that the plant should be in operation. He did not, however, fall down, but set his wits at work and surmounted the difficulty.

Procuring a piece of pipe, he cut it to the right length and slipped it over the rod. Then he fastened a wire from the box at one end to the eccentric strap to hold the rod in place. By this stroke of ingenuity he was enabled to keep the plant running until such a time as repairs could be made.

T. J. Movat.

### Main Bearing Repair

Editor Practical Engineer:

Figure 1 is a side view of main bearing with cap C of an old Holly quadruplex pumping engine, which was broken at H and I. The bottom box A has no adjustment, the two quarter or side boxes B B, are adjusted by wedges D. G G are cap screws holding the bearing to the top of the frame. K K are 2 straps 1¼ by 4 in., which were made to hold the broken pieces together. F F are adjusting bolts for the boxes B B. $F^1$ $F^1$ are adjusting bolts screwing through the straps against the broken cap C. Longer cap screws, reaching through the straps and cap, replaced those formerly at G. This cap was repaired

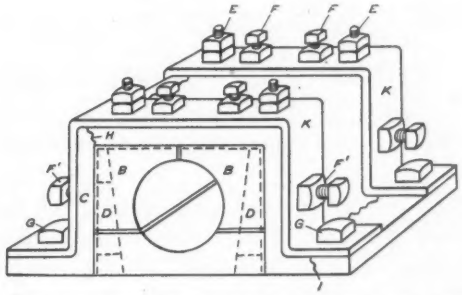



FIG. I. END VIEW OF MAIN BEARING REPAIR

several years ago and the engine is still making its 24 hr. a day run.

The cylinders of our Gaskell engine are steam jacketed, but on account of the steam leaking into the cylinder, the jackets had not been used for a number of years; it was determined to repair them.

The heads were removed, and the worn places were well cleaned, and all oil removed as thoroughly as possible. Smooth-on was used to fill the holes, gaskets cut, and heads replaced. The job was a success and saved the firm quite a little money, which would have been spent had other methods been tried. The cylinders are 24 and 48 in., respectively.

Tom Jones.

IN A CONDENSER OUTFIT it is estimated that the air pump handles 52 times the volume of the water resulting from the condensation of steam due to the following quantities: Condensed steam, 1 volume; air entering from boiler, 0.3 vol.; cooling water, 26 vols.; air with cooling water, 10.5 vols.; air from leakage, 14.2 vols.; total, 52 vols.

## THE INERTIA SHAFT GOVERNOR

THE majority of high speed engines in use are regulated by some type of shaft governor. Of the many designs, the Rites inertia is generally adopted by the greater number of builders.

It is a well known fact that no object can start itself in motion, from a state of rest; nor can it stop itself after set in motion. To do either, the object must be acted upon by some force outside itself. This means that if the object is at rest or in motion it will continue in that state forever unless acted upon by some outside force. This property of matter is called inertia.

If a bicyclist, when going at considerable speed, suddenly applies the brake, stopping the wheel sud-

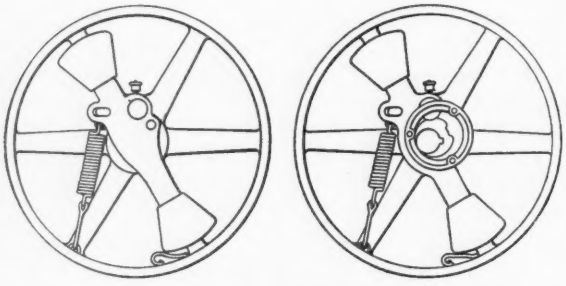


FIG. 1. THE INERTIA SHAFT GOVERNOR, OUTSIDE CONNECTED TYPE

FIG. 2. INSIDE CONNECTED TYPE OF GOVERNOR

denly, he will be thrown violently from his seat, in a forward direction. This is due to the property of inertia that his body possesses, making him unable to stop at the same instant that the wheel does. Should someone suddenly push the wheel forward from a state of rest, the rider will be thrown backward, from the inability of his body to start at the same instant the wheel does.

A common construction of the inertia governor is shown in Figs. 1 and 2. On some engines the wheel mounted on the crank shaft, containing the governor, has a heavier rim than its mate, when it is sometimes called the inertia wheel.

As seen in Fig. 1, the governor consists essentially of a single weight arm, a spring, an eccentric or eccentric pin, to impart motion to the steam valve, and a suitably mounted stud secured to one of the arms of the wheel to support the whole.

The weight arm is mounted on the supporting stud in such a manner, that it is practically divided into 2 parts, a long and short arm. The weight is supported very near the center of gravity of the mass. The spring is attached near the center of gravity also, and the other end is secured in a socket on the rim of the wheel. When the governor is mounted on the crank shaft between the wheel and frame, an eccentric is hung on a boss supported by the weight arm; when the governor is mounted outside the wheel an eccentric pin is used as shown.

If the spring should be removed from the weight and the wheel started to rotate in either direction, the weight would tend to remain stationary due to its inertia. The spring is attached to overcome the inertia of the weight and cause it to move with the wheel.

### Operation

From the previous paragraphs, it is seen that if an engine is running, and the load be reduced, the weighted arm will keep its position in the wheel until the increased centrifugal force overcomes the tension of the spring.

It requires some force to overcome the friction of the several parts of the valve gear. This means that during the instant required to move the weight arm, the wheel runs away from the governor parts so to speak. That is it reaches a given position in its revolution before the governor parts reach a corresponding point in their revolution.

The result is that the eccentric is swung backward across the shaft, giving the valve a less travel, resulting in an earlier cutoff.

When the engine starts from rest the tension of the spring is sufficient to overcome the friction of the valve parts. This gives the steam valve its greatest travel, and latest point of cutoff. As the speed increases the tension on the spring becomes insufficient to overcome the inertia of the weight arm, and the governor parts gradually lag a little behind the wheel. When the weight is moved in a backward direction in relation to the wheel, the center of the eccentric approaches the shaft center.

This shows that as the weight lags behind the wheel a little the cutoff becomes earlier. Should the load be increased, after full speed is attained, the wheel will lag behind the weight because the increased load for an instant checks the wheel. The governor will run away from the wheel, so to speak, and carry the eccentric forward across the shaft. This of course gives a greater valve travel and later cutoff.

### Changing the Speed

Usually the heavy ends of the weight arm are arranged in such a manner, that weights can be added and removed to change the speed as required. If we increase the weight of the arm by the addition of weights the inertia is also increased, which means that the weight will lag behind the wheel to a greater extent, as speed increases and the lagging behind decreases the throw of the eccentric by moving it in a backward direction across the shaft, thus giving an early cutoff.

Removing weights reduces the inertia and thus reduces the tendency of the weight arm to lag behind the wheel. This causes the weight arm to move the eccentric forward across the shaft, giving a greater valve travel and longer cutoff, which will speed up

the engine. The sensitiveness of the regulation can be controlled by the tension of the spring.

### To Change Direction of Rotation

The arm of the wheel opposite the one supporting the weight arm, when the engine is running, has a suitable hole in it for the reception of the stud that supports the weight. Also on the rim of the wheel will be found another receptacle for the head of the spring.

First, carefully measure the length of the spring; then remove the governor parts including the supporting stud. Insert the stud in the other hole and secure the head of the spring in the other pocket. Take up on the spring by means of the nuts until its length is the same as before. This will reverse the rotation of the engine.

The small spring is to give a little resistance to the governor, since if no resistance was given the parts would be inclined to require too much time to take up any definite position. This means that with a single arm the governor is statically unbalanced, and will have a tendency to fall forward during half of the stroke and backward during the other half. When the speed is over 200 r. p. m. it is not noticeable, but with slower speeds the cutoff will be affected, being longer on one end than on the other.

When the speed is less than 200 r. p. m. the governor action becomes jerky, which may send the governor through its whole range of motion.

To overcome this the small spring 1, is used. It acts on the end of the weight arm, just enough to prevent any sudden movement of the arm, but not enough to interfere with the changes of the governor position when a change in engine speed occurs.

### Care

The principal thing is to avoid all unnecessary friction in any of the governor parts, and the valve motion. This means that the parts are to be properly lubricated and kept clean. All oils or greases showing any tendency to gum should be avoided. Care should be given to the packing of the valve stem stuffing box. The packing should be renewed before it gets so old as to cut the valve stem. If the stem is worn to any extent, it is good practice to turn it down to its smallest diameter, thereby removing all chance of binding from that cause. The stuffing box should not be set up so tight that unnecessary friction is the result.

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SPEAKING OF OUR FUEL SUPPLY, Dr. J. A. Holmes, chief of the technologic branch of the U. S. Geologic Department, says that we waste two hundred million tons of coal a year through improper mining methods, such as taking the best part of the veins and leaving the rest, or cutting out lower veins of good quality and allowing the coal above to cave in and mix with the earth. This coal is worth at least $1 a ton and the amount wasted yearly is enough to supply the country for 6 months. Most of this waste is preventable by improved methods such as are used in Europe.

## SETTING THE SWEET MULTIPORTED VALVE

As the single ported valve driven by an ordinary eccentric motion cannot open the port quickly enough to keep up initial pressure at cut-off, the multiported valve has come into common use. This is so designed that the steam enters by 2 or more openings which open at the same time, thus giving large area and quick opening with short travel.

Drop in the steam line cuts down the power with no gain in other directions, hence, is to be avoided.

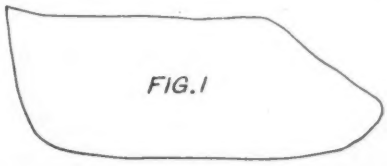


FIG. 1. INDICATOR DIAGRAM FROM SLIDE VALVE ENGINE

Fig. 1 shows an indicator diagram from a D valve engine with throttling governor at 220 r. p. m. On account of the slow opening, the piston "runs away" from the steam and the pressure falls rapidly.

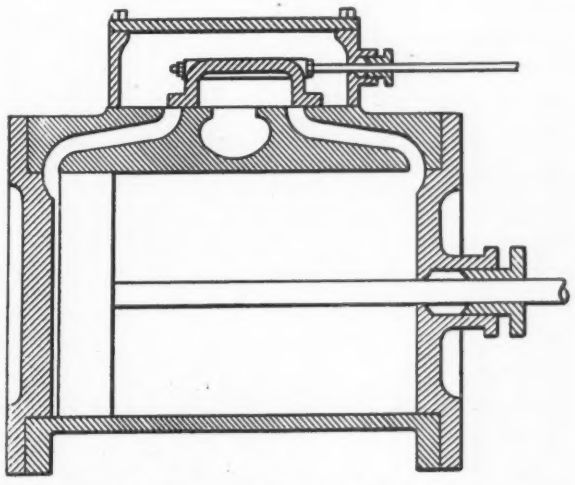

FIG. 2. PLAIN UNBALANCED SLIDE VALVE

### The Sweet Valve

The multiported valve most common for high-speed engines is that designed by Prof. John E. Sweet, and first used in the Straight Line engine. It has 2 ports admitting steam at the same time, both ports having large area so that ample port opening is given early in the piston stroke. The valve is a thin casting of rectangular shape with holes cored clear through; it runs between the flat seat and a cover plate, the distance between these being fixed by side strips. The cover plate is held to these strips by springs, so that the valve makes a steam tight joint between seat and cover plate and is balanced. Fig. 3 shows a section of valve and ports.

The valve usually stands vertical, running on its edge, which takes all the wear, so that this will not cause leakage.

Figure 2 shows the D valve as ordinarily used without any attempt at balancing. If the valve is 8 in. wide and 16 in. long, its area is 128 sq. in. and with pressure of 80 lb. in the steam chest, the total pressure on the back of the valve is 10,240 lb., which tends to decrease engine efficiency by causing large valve friction.

With the valve shown in Fig. 3 a portion of the back of the valve is covered by a plate called the pressure plate. This plate is adjusted to such a distance from the valve that the valve moves practically frictionless. The pressure plate takes the steam pressure, which, of course, relieves the valve of this pressure.

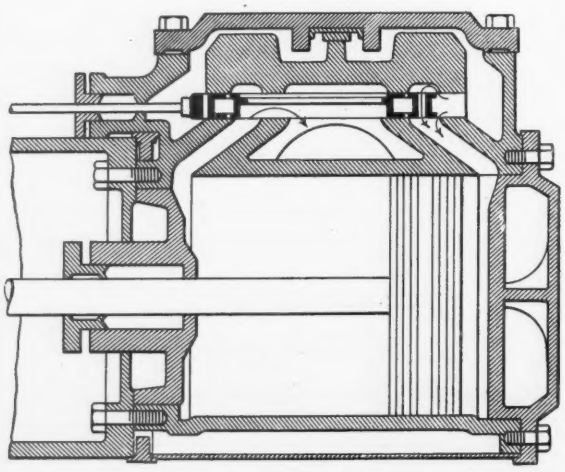

FIG. 3. SWEET BALANCED DOUBLE PORTED VALVE

The pressure plate position is adjusted by liners, wedges and screws in differently designed engines.

### Governor Gear

Many engines fitted with this valve are regulated by some form of shaft governor. The governor wheel is generally keyed to the shaft so that the position of the eccentric or eccentric pin is in proper position to drive the valve. Some of the smaller engines may have the governor wheel secured to the shaft by set screws, spotted, in which case the position of the wheel is readily located should it ever get out of place.

### To Set the Valve

Place the crank on head end dead center and equalize the movement of rocker arm, if one is used, and of the valve over the ports.

Block the weights in their outermost position. The valve should be on the point of opening on the head end and have the desired lead. If not, move the valve on the stem until it is in such position. Then move the weights toward the center of the shaft and note whether the valve is moved. If so, the lead is variable and setting is complete.

If the valve is not moved when the weights are moved, the lead is constant. The lead should generally be not over 1/32 in.

Owing to construction, the eccentric cannot be moved on the shaft readily, so that giving lead at 1 end is all that can be done. Because, if the valve is moved on the stem to give lead on 1 end, the other is disturbed.

Generally, a greater lead will be found on the crank end, which is done to compensate for the angularity of the connecting rod. This causes the cutoffs to become more alike when the crank end has a little greater lead. If the crank end is blind or has no lead, move the valve on the stem until it has some. It is good practice to secure the weights in the running position, and turn the engine over, noting the points of cutoff. If any great difference is observed, an unequal lead can be given to make the cutoffs more even.

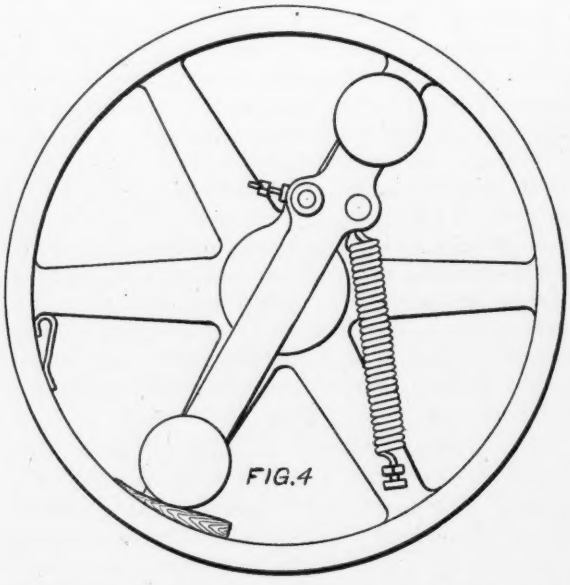


FIG. 4. GOVERNOR WEIGHT BLOCKED IN EXTREME POSITION

Care should be taken that the lead given is not sufficient to cause the engine to race on light loads. Fig. 4 shows the weights blocked in outermost position for valve setting.

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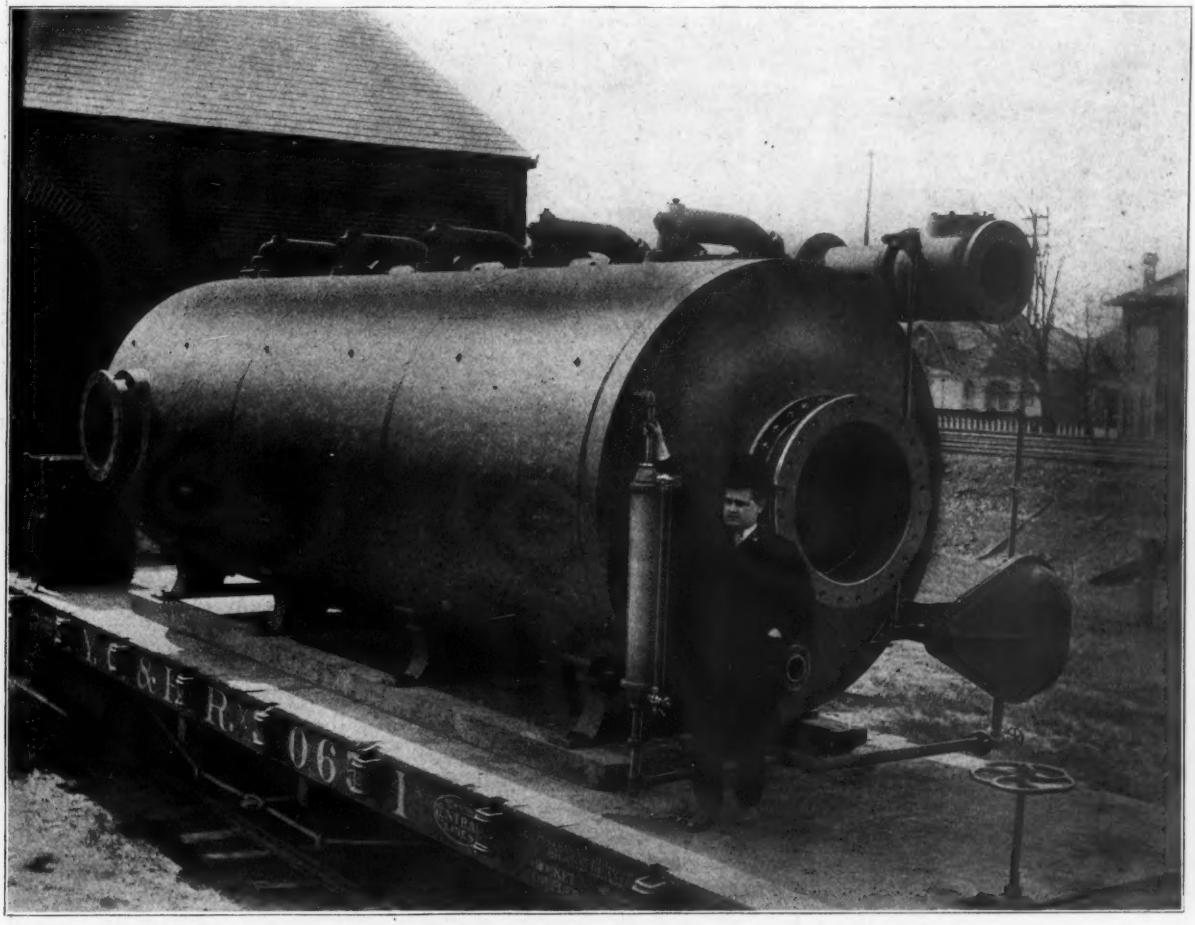
IN ORDER TO STOP the costly spring floods in southern rivers, the proposition is now being considered of establishing storage reservoirs to hold back the surplus water until needed; and of maintaining a forest cover in the mountains so that the soil will be porous and hold water instead of shedding it. It is stated by experts from the Geological Survey that this method will prevent the loss from floods, and make possible the maintaining of navigable streams without the need of continual dredging.

## A MAMMOTH FEED-WATER HEATER

The Hoppes feed-water heater and purifier shown in the halftone herewith is remarkable for 2 things; first, it is one of the largest ever built, being 90 in. in diameter and 22 ft. long and with a capacity of 20,000 hp. In the second place, it was made in 30 days from the time of receipt of the order and delivered to the Youngstown Sheet & Tube Co., of Youngstown, Ohio.

It has cast-iron shell and cast heads and pans, these pans being of the multiple trough shape with openings in the center so that the water trickles down through the center openings as well as over the outer edges, thus utilizing the bottom to better advantage in the collection of scale-forming matter. The pans are interchangeable and are of such form that they do not cement to the track.

The exhaust inlet and outlet are 30 in. in diameter and the regulating valve on the water inlet is 12 in. in diameter. The fire end of the heater from which the pans are removed has the head mounted with a crane attached to the shell so that the entire end can be swung back for removing the pans and cleaning out the heater, thus avoiding the necessity for any handholes or manholes. It was made by the Hoppes Mfg. Co., Springfield, O.



A MAMMOTH HOPPES HEATER

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EXAMINATION WILL BE HELD for assistant steam engineer on Aug. 26 by the U. S. Civil Service Commission. The vacancy is in the postoffice building at Salt Lake City, Utah, and pays $900 a year. The subjects for examination are letter writing, construction and operation of heating plant, engines, electrical and elevator machinery. Applicants must be citizens of the United States between 18 and 55 yr. and must get form 1052 from the Commission at Washington.

On Sept. 2 and 3 will be held examination for inspector of electrical and mechanical engineering in the office of the supervising architect of the Treasury Department. The subjects required will be arithmetic, plane geometry, simple algebra, trigonometry, practise of mechanical and electrical engineering, drawing and design. Two days will be required, and applicants must provide scale and drawing instruments. The age limit is 20 yr. or over. Application is to be made before Aug. 22 on form 1312, which will be furnished by the U. S. Civil Service Commission, Washington, D. C.

# MICHIGAN STATE CONVENTION

THIS could not fail to be a healthy convention as it was held in Battle Creek, the city noted for its attention to the health of mankind. As was expected, therefore, lively discussion, helpful papers and pleasant entertainments were the features of the meeting.

John I. Gibson, vice-chairman of the convention committee and representing also the Battle Creek Industrial Association, called the convention to order at 9 o'clock on July 16, and after prayer by the chaplain of the Sanitarium the delegates were welcomed by Mayor Green. Response was made by A. B. Benjamin, of Detroit, also by Waldo Francisco, state president of the association and by "Alphabet" Van Tassel, One of the interesting features of the morning session was an address by C. W. Post, on the Employer and Engineer, and reply to this by Edward G. Jacques, of Detroit, on the topic Engineer and Employer. Mr. Post advocated reasonable hours for engineers and the consideration of the workingman by the employer, while Mr. Jacques, on the other hand, outlined the duties of the engineer to his employer and showed what his qualifications should be in order to perform those duties. Other addresses were by Past President C. F. Wilson, of the National association, and by Aaron Miller on the Engineers' License Law. These addresses dealt with the functions of the association and with the work that had been done in Michigan for a license law. Mr. Miller emphasized the fact that license is required for the practising of his vocation from many whose callings have to do with the safety of human life, and that the engineer should be in this class, also that it is quite as much to the advantage of the employer as to that of the engineer to have a suitable system of examination and license in use.

The remainder of the morning was devoted to a short business session consisting of appointment of committees and hearing of brief reports.

**Afternoon Session**

This was taken up with reports of committees, and was comparatively short, the convention adjourning for a visit to the plant of the Union Steam Pump Co. In the evening a grand rally was held in the exhibit hall at 7 o'clock, after which lectures were delivered by F. A. Emory, of Grand Rapids, on Rope Driving; by G. R. Parker, of the General Electric Co., on Steam Turbines; and by Mr. Davis, of the Dodge Mfg. Co., Mishawaka, Ind., on Water Softening. These lectures were all particularly good and interesting and the association is to be congratulated on the introduction of so important and valuable an educational feature into its program. After the lectures, the fun began by the introduction of a vaudeville entertainment consisting of several artists alleged to be from New York, a series of moving pictures and special slides, one of these being the group photograph taken of the convention delegates early in the day. This performance was furnished by courtesy of the American Steam Pump Co., of Battle Creek.

FIG. I. GROUP OF DELEGATES AT THE PLANT OF THE UNION STEAM PUMP CO.

July 17 was devoted to the regular business of the convention, to a visit to the works of the American

Steam Pump Co., to a trip to the works of the Advance Pump & Compressor Co., another to the plant of the Postum Cereal, from there to the Battle Creek Sanitarium, and as a close to the day's entertainment a rally in the exhibit hall, trolley ride around the city and an evening at Goguac Lake for dancing and boating.

Saturday was given up by the ladies to shopping in the department stores under the guidance of a committee of the local ladies and by the delegates to regular business, including the election of officers and selection of a place of meeting for next meeting.

The officers elected for the coming year were: Past president, Waldo Francisco, Grand Haven; president, A. B. La Franier, Bay City; vice-president A. C. Benton, Battle Creek; secretary, E. C. Smith, Kalamazoo; treasurer, H. F. Brandau, Detroit; conductor, F. W. Collins, Hastings; doorkeeper, Clarence Ellis, Flint.

The program gotten out by the entertainment committee was a most interesting piece of work. It contained photographs of all the important plants and buildings in Battle Creek and a brief history of the city's growth and progress.

In Saturday's ball game there were numerous thrilling and alarming plays, the most spectacular features being the picture taken after the game and the scenes attending the spending of the $10 which the engineers won from the supply men by a score of 13 to 7.

At the close of the convention, Waldo Francisco, the retiring president, was presented with a beautiful cut glass fern dish and two cut glass bon bon dishes. All voted the convention the best ever held in Michigan, both as to business sessions, educational features and entertainments; in fact, some of the boys had so good a time that it is reported that they are staying in Battle Creek yet.

## IN THE EXHIBIT HALL

American Steam Pump Co. exhibited a model of a simplex pump, showing a section of the steam cylinder, and distributed handsome souvenir watch fobs to all visitors. A. C. Perkins, secretary, was always in evidence, and many of the pleasures of the convention were due to his untiring efforts. B. K. Gantt, of the advertising department, was an able assistant. On Friday morning, about 125 visitors and delegates took a trip through the immense plant, and all were cordially greeted by Mr. Hinman, president of the company. Every department was visited, and the unusual activity and number of men at work excited quite a little comment. Light refreshments and cigars were served during the progress of the inspection and everyone seemed to enjoy the affair thoroughly.

Kenneth Anderson Mfg. Co., of Detroit, displayed a line of Jarecki valves and fittings, Byres wrought-iron pipe, Williams valves and steam specialties. H. B. Gurney was in charge.

Crandall Packing Co. exhibit was in charge of J. M. Chapman and C. W. Scott of the Cleveland office, and B. M. Knobel of Chicago. A complete line of rubber sheet packings, gaskets, hose, and valve and disk packings were on display. Souvenir paper clips were distributed.

FIG. 2. EXHIBITS OF INTERNATIONAL CORRESPONDENCE SCHOOLS, JENKINS BROS., GREENE, TWEED & CO. AND DEARBORN DRUG AND CHEMICAL WORKS

Hawk Eye Compound Co. seemed to interest everybody in its product through the untiring efforts of the sales organization. H. E. Tibbles, W. F. Ebert, William Wiotte and W. O. Tibbles were always on duty, entertaining visitors and distributing souvenir fans to everyone.

Wm. Powell Co. was represented by M. F. Brenner, of the home office, who looked after the display, consisting of a full line of White Star and Union disk valves, globe and gate valves and Cyclone blowoff valves.

Garvin Ritchie & Son displayed the Dodge Mfg. Co.'s line of transmission and wood and iron split pulleys, also belts of the National Rawhide Leather Belting Co. Garvin Ritchie, Jr., was in charge.

Quaker City Rubber Co. distributed 6-in. steel rules to all who visited its exhibit, where they displayed a complete line of Quaker City products, including P. P. and Ebonite packings. C. C. Harris presided.

Union Steam Pump Co. The most interesting part of this exhibit was a side trip of inspection through the factory, where a large force of men were at work in

every department. This was a feature of Thursday afternoon's program and nearly all delegates and visitors participated in the event, and all were warmly welcomed by the officials of the company. A splendid group photograph was taken in front of the plant, and is reproduced in this issue. Copies of the photograph are to be mailed to all engineers who were in the group. Souvenir watch fobs were presented to visitors at the booth in the convention hall.

DIAMOND POWER SPECIALTY CO. exhibited its flue blower, and Mr. Herman was busy explaining its merits to all visitors.

H. W. JOHNS-MANVILLE CO. was represented by F. C. Frumveller and H. A. Pierce of the Detroit office of the company. Visitors to the booth were interested in the display, consisting of packings, pipe covering, No Ark fuses, Victor combination volt and ammeters and friction tape sockets. Souvenir rules were distributed.

THE GARLOCK PACKING CO. made a special display of its new No. 900 sheet packing in an attractive booth, which was in charge of A. H. Carr of the Detroit office. Souvenir key rings were distributed to delegates and visitors by F. S. Davidson of the Toledo office, who was in charge.

ADVANCE PUMP & COMPRESSOR CO. exhibited its duplex pumps. When not busy explaining the features of this line, C. A. Flynn was perfuming the passers with the aid of an atomizer, operated by a small motor driven compressor. On Friday a large number of visitors enjoyed a trip of inspection through the company's plant under the direction of L. B. Anderson.

DEARBORN DRUG & CHEMICAL WORKS' interests were looked after by Otto L. Fluegel of the Detroit office. Dearborn badges were pinned to all visitors and souvenir bottles of perfume distributed to the ladies.

INTERNATIONAL CORRESPONDENCE SCHOOLS had a pretty booth, defining the various engineering courses and displaying the bound volumes. E. A. Todd, the representative, conducted an unique guessing contest, the proceeds of which went to the state association. In a large sealed glass jar was an unknown quantity of beans, and the person guessing nearest to the correct number it

FIG. 3. POWELL VALVES, DIAMOND BLOWERS, GARLOCK PACKINGS, JOHNS-MANVILLE SPECIALTIES, DANIELS PACKINGS AND HAWK-EYE COMPOUND

A full line of their packing products were shown and souvenir ash and pin trays were presented to all visitors.

JENKINS BROS.' interests were ably looked after by Albert T. Arens of the Chicago office. The exhibit included a very complete line of valves and packings, and radiator valves and specialties.

GREENE, TWEED & CO.'s booth was in charge of F. E. Ransley, who was always in evidence, and visitors were told of the good points of Palmetto packings and the Favorite Reversible ratchet wrench. Cigars were free and everyone in attendance at the convention was decorated with the noisy little bugs which chirp for Palmetto.

VACUUM OIL CO.'s booth was in charge of G. B. Rickertson, who entertained visitors and presented match boxes as souvenirs of the occasion.

TAYLOR STEAM TRAP CO. showed the practical working features of its vacuum and steam traps. Mr. Taylor did the talking.

LAGONDA MFG. CO. had an interesting booth where were displayed its line of tube cleaners, tube cutters and automatic cutoff valves. The special demonstration of the new wing head on turbine cleaners was an attraction. Souvenir key rings were distributed to delegates and visitors by F. S. Davidson of the Toledo office, who was in charge.

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Other companies contributing and represented, but not having apparatus on exhibit, were Wickes Bros., The Lunkenheimer Co., Dodge Mfg. Co., Lake Erie Boiler Compound Co., Keystone Lubricating Co., Adam Cook's Sons represented by Silas C. Cook, Arrow Boiler Compound Co. by E. M. Swindler, Power by O. Monnett, Wm. Nugent Co., Green Engineering Co., Penberthy Injector Co., Central Electric Co., Detroit Lubricator Co., and Westinghouse Machine Co. represented by G. D. B. Van Tassel.

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IN A SERIES OF TESTS made to determine the effect of air in a condenser, Thomas C. McBride has found that with 6 per cent air the B. t. u. passed per square foot per hour for 1 deg. F. temperature difference was 372; for 14.8 per cent air, 348 B. t. u.; for 47 per cent air, 156 B. t. u., and for 75 per cent air 189 B. t. u. Hence in a condenser having the air drawn out at the bottom, the lower tubes are doing comparatively little work.

## CONVENTION OF MASSACHUSETTS STATE ASSOCIATION OF ENGINEERS

Shortly after 12 m. on July 10, the convention was called to order at Haverhill, Mass., by Chairman Thomas D. Brown of the convention committee, who welcomed the company and introduced Mayor Roswell P. Wood, who spoke of the beauties of Haverhill and the many sources of enjoyment open to visitors.

E. H. Kearney in reply thanked the Mayor and complimented him on the industries of the city. Mr. Kearney gave an outline of the history and objects of the Association, its stand for technical education of its members, its growth, its helpfulness and its influence in getting license legislation. He spoke also of the progress in engineering, fast trains, turbine steamers, air ships, and the part that Massachusetts has had in the work of the Association.

Fololwing this, Representative Nason spoke briefly of license law affairs and the advantage of education to the worker.

National President Joseph F. Carney complimented the delegates on the work of the state association and announced his conversion to the benefit of such organizations, and his advocacy of their establishment in other states on the Massachusetts model.

Others who spoke briefly were Past National President Kelsey, and State President George E. Leavitt.

After appointment of committees adjournment was taken until afternoon.

### Afternoon

In the afternoon reports of committees were received, the offer of 3 prizes of $15, $10 and $5 for the best work by local associations authorized, a continuation of the per capita tax voted and a message of sympathy sent to the widow of Nick Kelley of Buffalo. Substantial gain was reported in the treasury funds.

Election of officers resulted in the following: President, Ole B. Petersen, Boston; vice-president, Preston Tirrell, Haverhill; secretary, James H. Sumner, Somerville; treasurer, W. H. Damon, Springfield. They were installed by National President Carney, after which the business session adjourned.

Twenty-seven associations were reported in the state of which 24 were represented at the convention by 54 delegates.

### Evening Session

At 8:30 the delegates and their friends again assembled and marched to Tanner's Hall, where a banquet had been spread.

F. L. Johnson of New York acted as toastmaster, and introduced as speakers:

National President Joseph F. Carney of New York, who spoke briefly of the fine showing of the state association; Past National President T. N. Kelsey of Lowell, who believed in the state conventions, and reminded the members of that fact that education was necessary in order to keep posted and in order to keep from going down the ladder; Past National President Patrick H. Hogan who congratulated the state association upon its successful convention and splendid choice of officers; W. W. McLean, trustee of the National Engineer, who spoke briefly of the advantages of such a magazine to the engineer; State Deputy E. H. Kearney, who thanked the local secretaries for the aid given him in making his reports, and said that there was no lack of men of ability to fill the offices of the organization.

The officers for the coming year were next called upon in turn, and each expressed his thanks for the honor conferred upon him and stated his willingness to conduct the affairs of his office zealously, with the exception of Treasurer Damon, who side-stepped the oratory by slipping out the door before he could be called upon.

Saturday was spent in a sail to Black Rock and a trip to Hampton Beach for a shore dinner at the Avon House.

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## NEW YORK STATE CONVENTION

At the thirteenth convention of the New York State Association of Engineers, held at Jamestown, June 12 and 13, 27 delegates were present, representing 20 associations. After welcome by the mayor and response by George J. Wittman, addresses were made by E. E. Pruyn, state secretary, and Herbert E. Stone, past national president. The educational committee of 3 members appointed at the last convention was enlarged to 6, to reach all associations of the state, and the license law committee was instructed to prepare a proposed form of law within 90 days and submit it for vote to all subordinate associations. Officers elected were: J. C. Roberts, president; G. H. Woods, vice president; E. E. Pruyn, secretary; Charles Schabacker, treasurer; Stephen A. Wright, conductor; A. E. Kent, doorkeeper, and Stewart Warner, chaplain. On Friday afternoon those in attendance enjoyed a trip up Chautauqua Lake with supper at Bemus Point, and an evening at Celoron, returning by trolley to the city. Saturday morning was spent by the ladies in a ride about the city and after the session in the afternoon supper and a theater party at Celoron were provided.

Exhibitors at the convention were the General Electric Co., Chautauqua Electric Co., Garlock Packing Co., Henry R. Worthington, International Correspondence Schools, Sidney Valve & Supply Co., Dearborn Drug & Chemical Co., Jones Underfeed Stoker Co., Diamond Power Specialty Co., V. D. Anderson & Co. The next convention will be held at Syracuse, N. Y., June 11 and 12, 1909.

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OF THE RAW MATERIAL which can be utilized for the manufacture of alcohol, Indian corn gives the greatest yield. It has been calculated that the average price of potatoes must be reduced to 15 cents a bushel before they will be able to compete commercially with corn.

## NEW FILTER INSTALLATION FOR THE PENNSYLVANIA STEEL CO.

In past years the Pennsylvania Steel Co. has had a great deal of trouble from impure boiler feed water at its Steelton, Pa., plant. This plant consists of 3 250-hp. Babcock & Wilcox sets, and in spite of continual boring out, chipping off, and mechanical treatment generally, there was usually ⅛ in. or more of scale in the water tubes and steam drums.

In January, 1908, was installed a No. 5 Keystone Pressure Filter System, and the results to date are reported by the mechanical engineer, P. A. Cuenot, to be more than satisfactory. The boilers were opened in April, and the tubes and drums were found clear of scale, with none forming. Old scale had been reduced to a muddy consistency, mixed with small por-

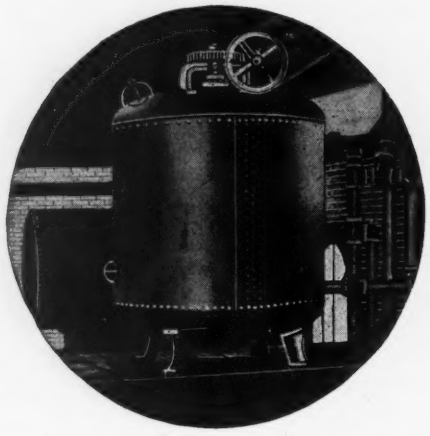


FIG. 1. KEYSTONE FILTER IN THE STEELTON PLANT

tions of scale, and most of this was in the steam drums. The little sediment found was in the tubes and drums, and was easily washed out with a hose.

Mr. Cuenot was especially pleased that the iron of the boilers had not been affected; and after the caps had been replaced and the boilers fired up the engineer in charge of the boilers reported no leaks. He says that the boilers make steam easier, and that the firemen have less work than before, thereby indicating a decreased fuel consumption.

The Keystone pressure filter system is extremely compact, and requires no settling tanks or other cumbersome apparatus, the Steelton installation, Fig. 1, being mounted on a platform overhead and taking up practically no room.

Its operation is two-fold. Dissolved scale forming materials such as sulphates and carbonates of calcium and magnesia are precipitated by chemical treatment as insoluble phosphates. In this form they are removed together with such suspended impurities as may be present, by filtering through a deep bed of crushed quartz. By this double treatment, the most destructive water goes into the boilers soft and harmless.

As may be seen from Fig. 2 the filter is simple in construction and operation. It is a cylindrical steel shell standing upright on strong cast-iron legs and contains a deep bed of crushed and sifted quartz. The seams are double riveted, for it must resist more than boiler pressure, being located between the feed pump

FIG. 2. SECTIONAL VIEW OF KEYSTONE FILTER

and boilers. At the top is a steel agitator operated by a worm gear, by which the filtering bed may be thoroughly broken up when desired. In the bottom of the bed of quartz is the system of strainers.

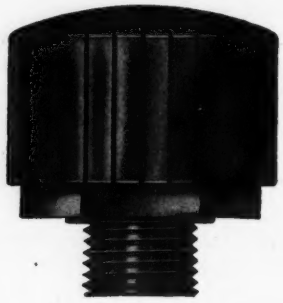


FIG. 3. KEYSTONE STRAINER HEAD

These are of considerable number and arranged to insure a uniform draft on all parts of the bed so that the work of filtration shall be evenly distributed throughout the bed of quartz.

The strainers themselves are of noncorroding bronze, and as shown in Fig. 3, the top is solid, thus enabling the weight above to be easily supported.

The openings for receiving the filtered water are vertical, in the sides of the strainers, and of ample total area to allow free flow of water to the outlet pipes. These latter unite in 1 central drain, which delivers the purified water to the boiler.

For washing the filter there are special pipe connections not shown in the cut, by which the sediment, foreign matter, etc., can be rapidly removed and carried into the sewer. The system is installed by the Keystone Chemical Mfg. Co., of Philadelphia.

## ADJUSTABLE ANGLE FITTINGS

Engineers and steam fitters have continually encountered piping propositions, especially in hotel and office building work, where the line had to be run on various angles caused by obstructions along the path the pipe should take. In many cases the angles were such as have no corresponding angle fitting in the

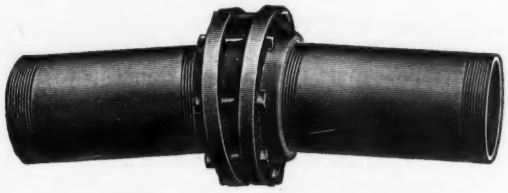


FIG. 1. AMERICAN WEDGE JOINT BETWEEN FLANGE FITTINGS

market, and it was a task with no assurance beforehand that the pipe could be bent with the facilities usually at hand to meet the requirements. The demand for flanges to make any required angle has been met by the product of the American District Steam Co., of Lockport, N. Y.

In order to make the joint, 2 wedges are inserted between the flanges, the taper being that required to

FIG. 2. AMERICAN ANGLE FITTINGS WITH BOLT SLOTS

cause the pipe to take any angle up to 10 degrees variation by simply turning the wedges.

The flanges have slots cut along the bolt circle, in place of the usual bolt holes, which allows the bolts to take the proper positions, when after adjusting to the desired angle the fitting is made up as usual. By these fittings many piping jobs are greatly simplified.

## TWENTIETH CENTURY METALLIC PACKING

In order to reduce the very considerable expense of packing piston rods and valve stems to a minimum, to reduce frequency of renewals and avoid scoring of rods, metallic packing has been developed to a high degree of perfection. Twentieth Century Packing is made and marketed by the Metallic Packing and Manufacturing Co., of Elyria, O., and is composed entirely of metal. It is, therefore, practically frictionless and has great wearing qualities.

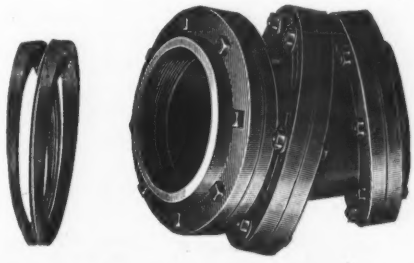


FIG. 3. WEDGES AND ANGLE JOINT FLANGES

The rings, of which the packing is composed, are made in segmental sections to fit the rod perfectly, and are very sensitive to any unevenness. The rings are cut tangentially, which permits the sections to expand and contract, thus securing flexibility, a quality necessary to long life.

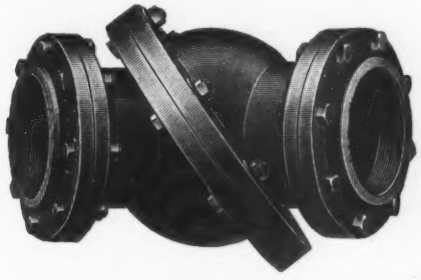


FIG. 4. SPHERICAL FLANGE FITTING FOR A DOUBLE BEND

A ring, termed the guard ring, is inserted at the bottom of the stuffing box, and takes the direct impact of the steam from the cylinder. This assists in making a tight joint.

Each ring has a groove turned in its back, into which a spiral spring encircling the whole ring fits, thus allowing for any unevenness in the rod, and following up the wear. The entire packing fits in a suitable casing secured to the stuffing box studs, and there is no necessity to disconnect the piston rod from the crosshead when applying.

The packing is easy to apply, has long life and requires no following up.

ONE SQUARE FOOT OF GRATE SURFACE will consume on an average 12 to 18 lb. of coal per hour with natural draft and hand firing.

## THE SQUIRES REDUCING VALVE

To meet the need for a simple and reliable device for reducing pressure for heating, the Strong, Carlisle and Hammond Co., of Cleveland, O., has perfected the Squires reducing valve shown in Figs. 1 and 2.

The Chamber containing the main valve supports the main diaphragm chamber on a suitable frame, on which the pilot valve A is mounted.

A pipe from the system using the reduced pressure is connected to the top of the pilot valve chamber, and the heavy spring acting on the back of the piston, to which the diaphragm is secured, opens the valve whenever the pressure is below that for which the valve is adjusted.

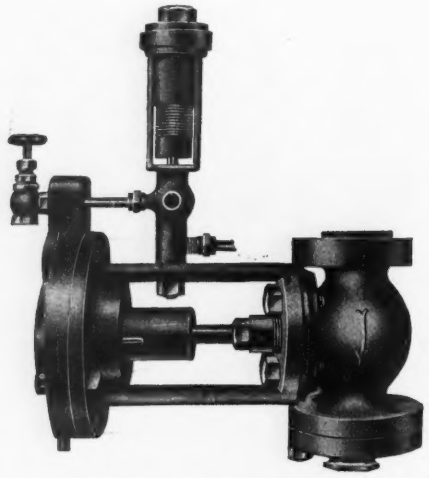


FIG. 1. EXTERIOR OF SQUIRES REDUCING VALVE

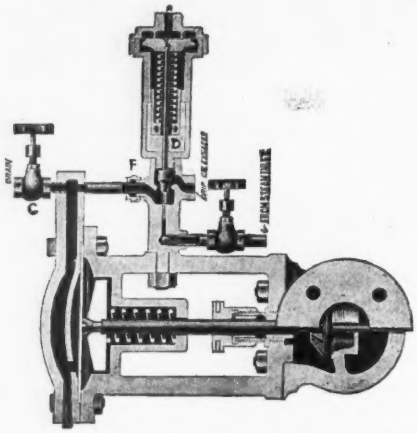



FIG. 2. SECTION OF SQUIRES REDUCING VALVE

As 25 lb. is all that is required to operate the main valve, any surplus is reserve power, giving certainty of operation should the stuffing boxes be tightly packed.

The main valve in the steam pipe is controlled by the spring and diaphragm in the diaphragm chamber. When the system is first put under reduced pressure, the main valve is held off its seat by the spring mounted on its spindle. The steam then rushes through the system.

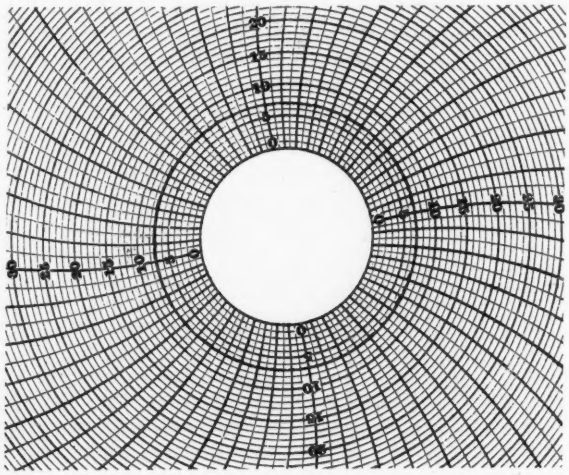


FIG. 3. DIAGRAM SHOWING ACTION OF REDUCING VALVES

A small pipe connects from the low-pressure side to the pilot valve A, and, when the desired pressure has been reached, its influence is exerted on the diaphragm mounted on the spindle of the pilot valve.

This causes the pilot valve to travel downward, closing the drip connection shown in Fig. 2. The high-pressure steam being piped through the valve B and connection F into the main diaphragm chamber, where it acts on the diaphragm of large area, closing the main steam valve.

When the low pressure drops below that for which the valve is adjusted, the spring under the pilot valve raises that valve, allowing the high-pressure to be bypassed, or diverted through the opening from the main chamber, thereby allowing the heavy spring to open the main valve.

Figure 3 is a chart from a recording gage showing the steady action of the Squires reducing valve.

## THE POWELL TITAN LEVER THROTTLE VALVES

These valves are for quick opening for the control of liquids or vapor and are designed especially to give tight seating with a quick opening valve. They are of the gate valve type having 2 disks which seat against the faces of the valve body and wedge the disks apart after being seated in place by a swinging toe. In the illustration, E E are the disks carried on two pins, F F. They are swung back and forth to and from the seats by means of the arm C and the shaft B. After the disks are in place the wedge G swings between them, forcing them apart and against the seat of the valve body.

In opening the valve the wedge is first removed from between the disks and then the disks are lifted from the seats. On closing the reverse action occurs,

the disks being first placed in front of the seat and the wedge then carried between them, so that there is absolutely no friction on the seat. The valves are made in 2 grades, the Titan for 155 lb. pressure and the

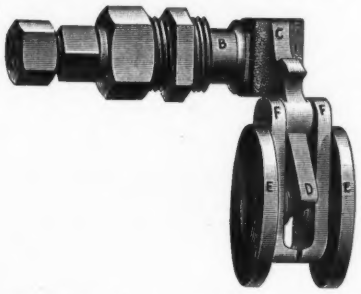



FIG. 1. WORKING PARTS OF TITAN QUICK OPENING VALVE

Giant for 350 lb. pressure, and in sizes from ½ in. to 3 in. in bronze, and 1 in. to 8 in. in iron. They are made with screwed or flanged ends, by the Wm. Powell Co., of Cincinnati, Ohio.

## A NEW HOT WATER SERVICE HEATER.

A large demand always exists in hotels, office buildings and laundries for hot water. If this water can be heated by exhaust from the engines and auxiliaries a decided saving can be made.

Frank L. Patterson & Co., of 29 Cortlandt St., New York City, have recently brought out a heater designed for this service.

FIG. 2. TITAN VALVE ASSEMBLED

The shell of the heater is cylindrical in shape, having 1 head securely riveted in place. The other head is held by suitable studs, allowing easy access to the tube sheet to which are secured 2 sets of brass U tubes, through which the steam circulates. The chamber between the tube sheet and the heater head being divided into two compartments, the steam enters 1, passes through the tubes and out from the other connection. With the construction illustrated, live steam is admitted only when the volume of exhaust is insufficient to maintain the desired temperature.

A NEW HOT WATER SERVICE HEATER

## NEWS NOTES

EXAMINATION WILL BE HELD on Aug. 3 for Chief Engineer, Class 3, Coast and Geodetic Survey, for service in the Philippines and other vacancies as they may occur. The salary is $115 a month, and on arrival at Manila the appointee will be promoted to chief engineer of the first class at $140 a month. Age limit is 25 to 45 years and each applicant must present a license from the U. S. Local Inspectors of Steam Vessels, as chief engineer for ocean, 500 tons, or a certificate from the Steamboat Inspection Service that he has such a license. The examination is on the following subjects: Education, shop practise, engine-room practise, reliability, deportment. Forms of application can be had from the U. S. Civil Service Commission, Washington, D. C., and must be filed with the commission at Washington on or before Aug. 3. Form 304 and special forms are those needed.

SINCE THE PLACING with Allis-Chalmers Co. of an order for a 100 stamp mill or ore reduction plant, to be operated by the Goldfield Consolidated Mines Company, Goldfield, Nev., the most notable evidence of renewed activity on the part of large mining companies is a contract just let by the Cerro de Paso Mining Co., controlling extensive properties in Peru and Argentina, for 8 enormous roasting furnaces, with all auxiliary machinery. Each equals in height a building of several stories and is capable of treating the daily output of a good sized mine.

CONTRACT FOR THE ENGINES for the new power plant of the Bigelow Carpet Co., Clinton, Mass., has just been awarded through the office of Chas. T. Main, engineer, Boston, to the Providence Engineering Works, Providence, R. I. It includes a 400-hp. noncondensing and a 1000-hp. compound condensing engine, both of the horizontal type.

AMERICAN STOKER CO. now has its general office in the Park Building, Pittsburg, Pa. It has installed as chief engineer, John Van Brunt, who has had several years' experience with the stoker problem. The company has also made close alliance with the steel interests which puts it in favorable position to supply both chain grate and underfeed stokers.

THE L. S. STARRETT CO., which is noted for its output of fine mechanical tools, announces the opening of a warehouse at 36 and 37 Upper Thames St., London, England. Here a full stock of tools, saws, tapes, etc., will be carried, orders executed and payments received. For the English trade a new catalogue has been prepared with prices in the English system. The branch will be in charge of E. P. Barrus.

ONE OF THE ENCOURAGING SIGNS in the increase of business is the news of the erection of a large additional factory building, 60 by 200 ft., at Youngstown, Ohio, by

the General Fireproofing Co. This will be put to a novel use, viz., the manufacture of steel office furniture and filing devices to take the place of wood. This includes unit filing systems, desks and tables, and the furniture is finished to resemble closely oak or mahogany. It is not only fire-resisting, but occupies small space, is not injured by use and is unaffected by moisture.

RIVERSIDE ENGINE CO., Oil City, Pa., builders of the Riverside Heavy-Duty gas engine, has extended its sales organization by opening an office in the Rockefeller Bldg., Cleveland, Ohio, in charge of the Holbeck Co. The above company's shops have been running full time in spite of the recent financial depression.

AS AN INDICATION of the revival of demand in the steel industry comes the placing of an order for 3 vertical blowing engines of the largest type ever constructed, to furnish blast for new furnaces which the Worth Bros. Co., of Coatesville, Pa., have decided to erect. Also the Sloss-Sheffield Iron & Steel Co., of Birmingham, Ala., has bought another blowing engine of similar type for immediate delivery. The size of these machines can be imagined from the fact that the tallest man could stand erect in the air cylinders and have room to carry an umbrella. These orders have been placed with the Allis-Chalmers Co., which has already built nearly 400 of them, with an equal number of horizontal blowing engines, the total output of air approximating 12,000,000 cu. ft. a minute.

## PERSONAL

THE FILER & STOWELL CO., of Milwaukee, Wis., which builds heavy-duty Corliss engines, is again represented in Chicago and vicinity by Frank Engelhardt, with office at 735 Marquette Building. Mr. Engelhardt, with the exception of a short period, has been handling the Filer & Stowell engines for about 10 years.

J. B. KANE, who has had several years' experience in the factory of The American Steam Gauge & Valve Mfg. Co., has been promoted to the position of salesman, and will make his headquarters at the New York branch of the company mentioned.

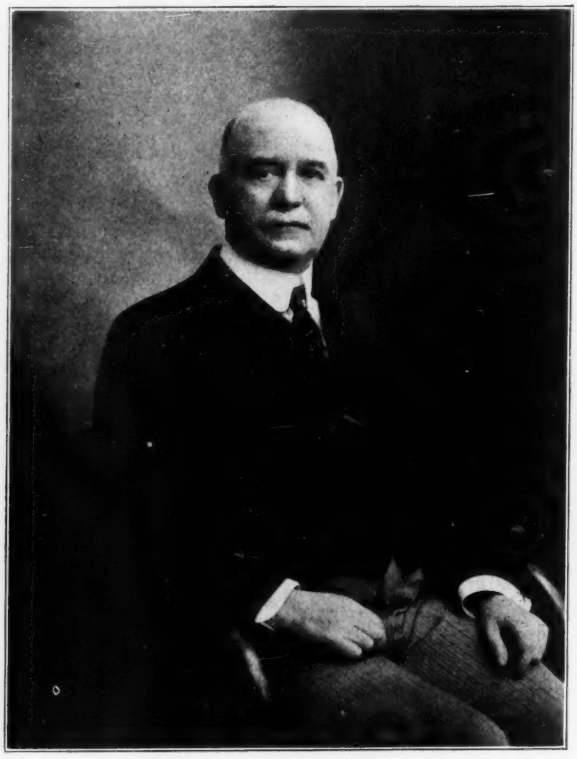
C. S. KIESSLING, who has been employed in the general offices of The American Steam Gauge & Valve Mfg. Co. for several years, has been transferred to their Chicago office, and will have charge of the order department.

## CHARLES H. DALE

With the deepest regret we have to record the death of Mr. Charles H. Dale, which took place at his home in Larchmont, N. Y., July 18th. Mr. Dale is a man well known in the power plant field, and who to all appearances had many years of active and useful life before him. He was but 56 years of age, of robust appearance and apparently in the best of health; but 10 days previous to his death he was stricken with heart disease and never recovered. His death comes therefore, as a great shock to his family, to his business associates, and to his host of friends throughout the country.

Mr. Dale's connection with the Rubber Industry began some 17 years ago. Previous to that time he was engaged on the West Shore Railroad as conductor and finally as train master, and for several years was chief conductor of Association No. 54 of the Order of Railroad Conductors. After changing to rubber goods manufacture he rose rapidly and to a position of the highest responsibility.

He was president of the Rubber Goods Manufacturing Co., of the Peerless Mfg. Co., of the N. Y. Belting & Packing Co., Ltd., and of the Mechanical Rubber Co. Outside of the rubber industry he was also prominent in financial and social circles. He was director of the Merchants' Exchange National Bank, and of the Century Bank, and a member of the New York Yacht Club, The Larchmont Yacht Club, New York Athletic Club, Automobile Club of America and the Union League Club. He was also a high-degree Mason.



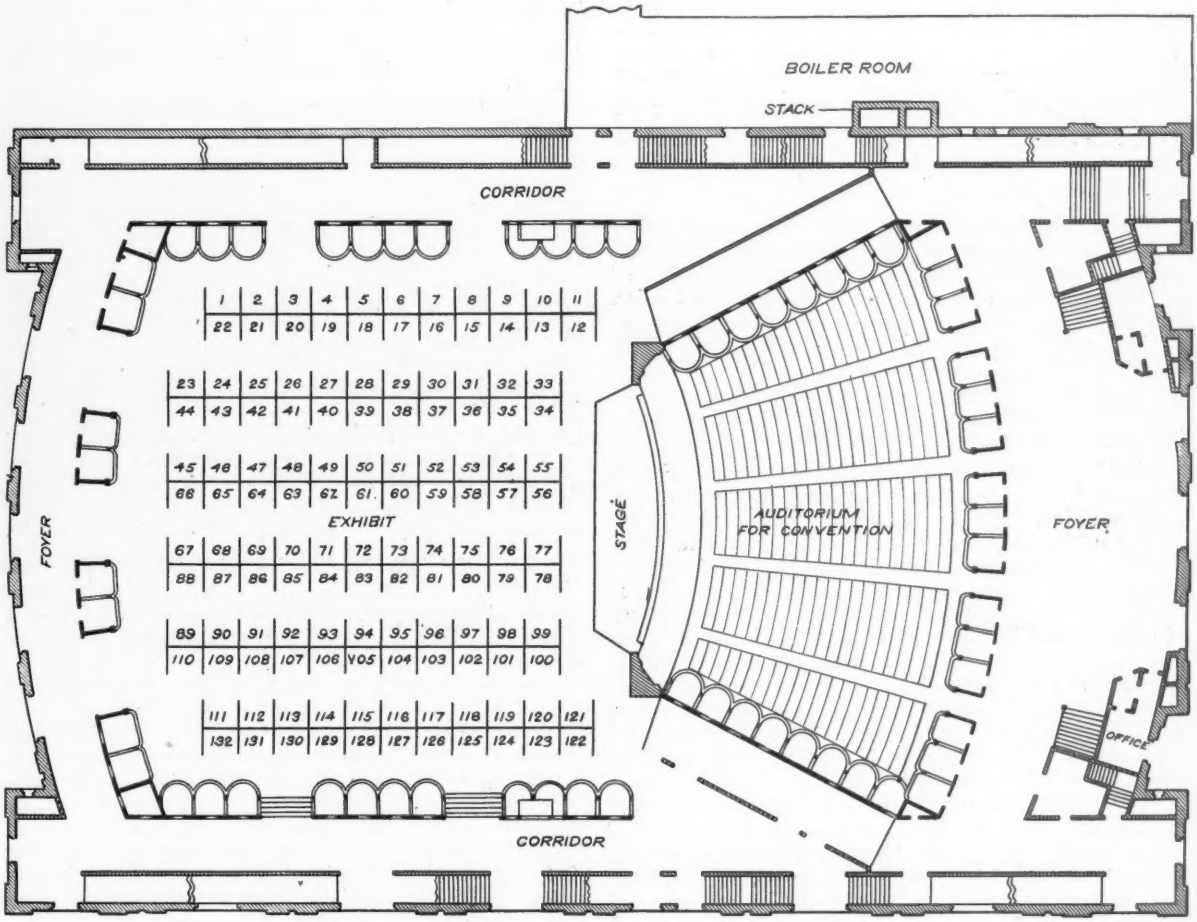
CHARLES H. DALE. PHOTO BY DAVIS AND EICKEMEYER

Mr. Dale was a man with a keen insight into the affairs of life, and into the character of man. He was always kindly to his employes and associates, and this with his good judgment enabled him to gather about him in the different departments of his various companies, most excellent men. He was generous to those who needed his help, both in the matter of giving to charity and with advice and sympathy to those in trouble. He has occupied a large place in business affairs, and in the hearts of his friends, and his loss will be greatly felt.

## SOCIETIES

ON OCT. 5-10 the first International Congress of the Refrigerating Industries will be held in Paris, under the patronage of the Ministers of Agriculture, of Commerce and of Industries. Section 1 of the meeting will take up the Effects of Low Temperatures; Sec. 2, Refrigerating Appliances, including Machinery and the Construction of Cold Storage Rooms; Sec. 3, the Application of Refrigeration to Food; Sec. 4, Refrigeration in Other Industries, such as horticulture, brewing, ice making; Sec. 5, Refrigeration in Commerce and Transport; Sec. 6,

Legislation. The American committee in charge of arrangement sconsists of David R. Francis, honorary president; Homer McDaniel, president; John E. Starr, vice president; John S. Field, treasurer; J. F. Nickerson, secretary; T. S. McPheeters, chairman of the executive committee; Theo. O. Vilter, chairman finance committee; J. C. Stubbs, chairman; J. S. Leeds, vice chairman, and E. F. McPike, secretary of the railroad and steamship committee, and Theo. Kolischer, chairman of the transportation committee. The papers presented at the congress will be printed in pamphlet or book form and each regular member who pays a fee of $5 will be entitled to copies of all publications. Besides the regular sessions of the congress there will be elaborate social entertainment in the form of receptions, banquets and excursions.




CONVENTION AND EXHIBIT HALLS AT DENVER

RESERVATION FOR EXHIBIT SPACE at the Denver convention is going on rapidly. The spaces will be 8 by 6 ft., giving 48 sq. ft. of floor surface, and will be on the same floor as the auditorium, as shown in the accompanying plan of the building. Reservation can be made with William D. Purcell, Quaker City Rubber Co., Philadelphia, Pa., but reservation will only be made when check accompanies the order. The charge for each space is $25. The spaces will be assigned in the order of receipt of applications. Many exhibitors are taking 2 or more spaces and the demand is great. Direct current at 220 volts will be supplied for those who wish it. It is expected that over 2500 delegates and visiting engineers will attend, and an elaborate program of entertainment has been arranged. All mining and mechanical men throughout Colorado and the west will be invited to visit Denver during the convention, which will be held Sept. 7 to 12.

## BOOKS AND BOOKLETS

THE REFRIGERATING ENGINEER'S POCKET MANUAL, by Oswald Gueth. New York, 1908. Cloth, $1.50.

This book of 150 pages, fully illustrated, is divided into five sections, treating of 1. Principles and Properties; 2. Refrigerating Machinery; 3. Applications of Mechanical Refrigeration; 4. Operation of Compression Plant; 5. The Steam Plant. This is not an extended treatise on the subject of refrigeration but, as the author says, is a digest of rules and data of every branch of mechanical refrigeration embodying opinions of the foremost men in the field, together with practical experience, and it has at the end a considerable number of blank pages for the record of the user's experience. It gives, however, a clear idea of the action of the different styles of machines, including the vacuum, absorption and compression systems, and contains a large number of tables as to capacities, power and dimensions for such machinery. The author has had many years' experience in the practical operation of ice plants and in the preparation of articles on refrigeration subjects. As might be expected, therefore,

the book is well edited and the data well chosen and it will be found of great service to either the designing or the operating engineer.

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ALLIS-CHALMERS CO. has prepared a bulletin describing in detail the American Blower Co.'s engine direct connected to an Allis-Chalmers generator. This has been done in response to many requests received during the last few weeks for information regarding small generating sets. These sets are suitable for small plants in buildings, residences, shops and factories and are compact, light in weight, simple, reliable and durable. Full details are given in Allis-Chalmers bulletin No. 1042A, which can be had on request from that company.

DIRECT SEPARATORS is the text of an attractive booklet just issued by the Direct Separator Co., of Syracuse, N. Y. Anyone who needs a separator for steam, oil or ammonia or who expects to need one will be interested in this. It is beautifully printed. It tells about the why of separating water and oil from steam and the how of Direct separators; methods of installing and draining and the make up of Sweet exhaust heads. Sent on application.

SUPERHEATER LOGIC tells of the construction of the Heine superheater, which is especially adapted to be used in connection with a water-tube boiler of the horizontal type. It consists of a sheet steel header, into which open a series of bent tubes, the steam flowing back and forth in these tubes until it is sufficiently superheated for the purpose desired. The device is mounted above the boiler proper and is heated by the gases from the boiler furnace. This device is manufactured by the Heine Safety Boiler Co.

GAUGES AS MADE BY THE American Steam Gauge & Valve Mfg. Co., is the subject of a 127-page catalogue just issued. Besides general information on the subject of different styles of gages, a full description of each type as manufactured by the American Co. is given, with illustrations and price-list. These are made with single and double spring, for all classes of engines and boilers, for all ranges of pressure, for steam, water and air and in single and duplex forms. In addition to the gage list is given description of revolution counters, gage testers, calorimeters, draft gages, thermometers, whistles, water columns, and gage cocks. The recording type of gage is specially shown and its uses described.

WASTE POWER is the title of an interesting booklet issued by the Metallic Packing & Mfg. Co., of Elyria, Ohio. It treats of the saving in horsepower secured by using the right kind of packing on piston rods and valve stems and gives the results of some tests made to determine the saving that could be effected in horsepower and in water and coal consumption.

BUCKEYE ENGINE CO. of Salem, Ohio, has just issued a handsome and most interesting booklet of the Buckeye 4-stroke cycle gas engine. It describes the double-acting tandem type, the single-acting type and explains by diagrams and analysis exactly what happens on the 4-stroke cycle. Comparison is also given of the thermal economy of gas and steam engines and a discussion of the fuels available for power and of their value.

SIMS FEED-WATER HEATERS is the title of Catalog G issued by the Sims Co., of Erie, Pa. This tells all about the construction of these heaters, gives tables of dimensions and capacities and describes in full the newest device of the company, the Sims instantaneous hot water generator. Sectional views and description are given of the Sims open feed-water heater and of the Sims condenser for ice plants, also of the Sims water softener, which is a device to be installed on the pipe line between pump and boiler for the purpose of feeding continuously compounds used for the purification of the feed water. This catalog is interesting and up to date. It is worth having.

COAL PILE DIVIDENDS is the attractive title of an attractive booklet issued by the Skinner Engine Co., of Erie, Pa. It shows how by proper selection of apparatus and in particular the use of an engine that has a good steam economy, the coal bills may be cut down to the point where money will be available for the comforts and luxuries of life, such as good houses, automobiles and "sich." Furthermore, the figures are given to prove the statements made in the catalog.

GET AWAY FROM THE WEAR AND GRIND OF HAND LABOR is the text of a booklet and circular sent out by the Loew Mfg. Co., of Cleveland, Ohio, describing its Victor pipe machine. This is the 1908 model, made in belt power and hand power types and in various sizes for different sizes of piping. The booklet tells all about it.

IN THE 22nd EDITION of its catalogue the Murphy Iron Works, of Detroit, Mich., describes the Murphy automatic smokeless furnace. The furnace is shown in section and in detail, all parts being fully illustrated and described so that the action is perfectly evident. The furnace is of the automatic feed type with coal spread from the sides and burning under a firebrick arch. Different styles of furnace for different types of boilers are shown and also a number of plants where the Murphy furnace is in use. The catalog is handsomely printed and contains 40 pages.

GREENE, TWEED & CO., of 109 Duane St., New York City, in its 1908 catalog of specialties has produced a book well worth the attention of all engineers. The specialties are well illustrated, so that their purpose and use can readily be understood. They include belt studs, clamps and other accessories for the fastening of belts, packing, wrenches, speed indicators and other supplies, including among the packings Palmetto Twist, Crescent Square Flax, Palmetto square and round, and among tools the Champion chain pipe wrenches, the Favorite reversible ratchet wrenches, hammers, speed indicators, water gages and glass cutters, hose and fixtures. Rochester lubricators are also fully illustrated and described in the catalog in any number of feeds, and full instructions are given for the attachment and operation of these instruments.

PRESSURE AND VACUUM GAGES for all purposes is the title of an interesting bulletin which shows single-spring, double-spring and auxiliary spring standard gages for pressure and vacuum, for water systems, for ammonia, for air brake systems, and for paper mills. One special type is the steel diaphragm for sulphite; another is the illuminated dial. Recording gages and clocks are also listed. Full dimension tables are given. These gages are made in two models by the Standard Gage Mfg. Co. of Syracuse, N. Y. Model A has the pressure tube and movement so designed that they are independent of the case, hence no change of temperature can affect the accuracy. Model B is designed to meet usual commercial requirements on the lines of ordinary gage construction.

A WELL GOTTEN UP CATALOG has been received from the Kennicott Water Softener Co., Railway Exchange Bldg., Chicago, Ill., describing and illustrating the Kennicott Water Softener. The catalog is printed on a heavy buff paper, in large bold type, easy to read. The illustrations are good, and show the softener installed under various conditions. The sectional cuts and descriptions give a clear understanding of the apparatus.

BOILER LOGIC by the Heine Safety Boiler Co., is intended to indicate to boiler users, engineers and others the position of that company in the field and describes its product under the headings of Economy of Fuel, Safety and Durability, Economy of Space, and Accessibility for Cleaning. The detail parts of the Heine boiler and its construction are shown and fully described.

## TRADE NOTES

RECENTLY THE ALLIS-CHALMERS CO. has been awarded contract for machinery as follows: Pittsburg Steel Co., Pittsburg, Pa., one horizontal vertical compound condensing engine for rolling mill service, capable of developing 2500 hp. continuously on economical load, and 50 per cent in excess of this on maximum load. Six-tenths of this power will be transmitted through belting from a band wheel 18 ft. 6 in. in diameter, with 60 in. face and weighing 100,000 lb. The balance of the power will be transmitted directly through the shaft to the rolling mill.

Tennessee Coal, Iron & Ry. Co., of Birmingham, Ala., has ordered 1 horizontal cross-compound condensing 2 stage air compressor, the steam end being a cross-compound condensing Corliss engine of heavy duty type with steam cylinders 26 and 48 in. diameter and a stroke of 48 in. and with air cylinders of sizes to correspond. This compressor has a capacity of 4,000 cu. ft. of free air a minute based on piston displacement when operating at 65 revolutions and discharging air at a pressure of 80 lb. gage. It was designed for 150 lb. steam pressure and 26 in. vacuum and has a wheel 18 ft. in diameter weighing 40,000 lb. Between the high and low-pressure air cylinders an intercooler will be installed containing over 1000 sq. ft. of cooling surface.

BUCKEYE BOILER SKIMMER CO., of Toledo, Ohio, recently received from Sykes Bros., of Philadelphia, the following letter: "In reply to your inquiry as to whether your skimmer has proven satisfactory or not, beg to say that it has been in 1 year now, and has given us entire satisfaction in every way, and we would not hesitate to advise anyone to put it in. We would not like to be without it now."

STILL ANOTHER ORDER for Swartwout gravity closing ventilators, the fourth in the series, has recently been received by the Ohio Blower Co., Cleveland, O., from the Richardson Paper Co., Lockwood, O. This order adds 12 more 24 and 36 in. ventilators to the 54 already furnished this company; a total of 66 in 4 months.

CHANGES AND IMPROVEMENTS in equipment of Stott's Flour Mills, Sixteenth and Grand River Ave., Detroit, Mich., have been recently completed, one feature of which was a newly installed power plant designed along the most approved lines for flour mill service. The main mill drive is furnished by an Allis-Chalmers Tandem Compound condensing engine of the heavy duty type, with cylinders 18 and 36 in. in diameter and a 42-in. stroke; steam is used at 130 lb. gage pressure. The exhaust from the engine passes to a surface condenser and then to an open feed-water heater, whence it is fed, along with the additional feed water necessary to 3 Babcock & Wilcox water-tube boilers, 2 150 hp. and 1 250 hp. fitted with Murphy stokers and overhead coal feed. The Stott Mills are divided into 2 general groups for winter and summer wheat respectively. They have been in operation a number of years, being equipped originally almost entirely with Allis-Chalmers flour mill machinery. The capacity of the Stott Mills was approximately 1000 bbl. per day, which output has been increased at various times by the addition of new machinery and is today nearly 1500 bbl.

SEVERAL NEW EXHIBITORS have recently been added to the list in the Philadelphia Bourse Exhibition Department, among them the following:

The Union Twist Drill Co., Athol, Mass., has taken space for a handsome display of its line of drills and cutters, and has its office within the space leased; The Monarch Emery and Corundum Wheel Co., Camden, N. J. has taken space for the display of its line of Corundum wheels and shapers, of which it makes all kinds. Its goods are in a glass case with a revolving center, driven by a ½-hp. electric motor. The Carr-Harrison Tool and Supply Co. of Philadelphia, has space and office room and will display many of the various lines of goods for which it is agent, including tool steel, seamless steel tubing, high-speed steel, drills and tool holders. Messrs. Daley & Davis of Philadelphia have taken space for the display of metal, wood-working and electrical machinery and the American boiler flue cleaner, for which they are the general agents. They also have an office in the space with the exhibit, which makes it convenient for the buyer.

A HANDSOME PICTURE IN COLORS 4.5 by 8.5 in. of a Murray Corliss Engine will be sent to any engineer in charge of a power plant who agrees to frame and hang it in his engine room. He need only write to The Murray Iron Works Co., Burlington, Iowa, and mention Practical Engineer.

YORK MANUFACTURING CO. has recently made large sales as follows: Bahamas Timber Co., Ltd., Wilson City, Abaco Island, The Bahamas, 1 complete 10-ton ice making plant; Jos. McWilliams & Co., Louisville, Ky., 1 6-ton compression side; Standard Oil Co., Bayway, N. J., 2 150-ton absorbtion plants; Crest Hall Hotel, Winthrop, Mass., 1 3-ton refrigerating plant; H. P. Porter, Sarasota, Fla., 1 complete 15-ton ice making plant; Brownsville Cotton Oil Co., Brownsville, Tenn., 65-ton refrigerating machine, 30-ton freezing and distilling system; Crystal Ice Co., Sanford, Fla., 1 complete 60-ton ice making plant; Carlstadt Consumers Ice Co., Carlstadt, N. J., 1 complete 20-ton ice plant; Maier Brewing Co., Goldfield, Nev., 6-ton refrigerating plant; Isaac M. Taylor, Morgantown, N. C., 10-ton ice making plant; J. A. Pauli & Co., New York, N. Y., 6-ton ice making plant for export; United States Candy Co., Cleveland, Ohio, 1 20-ton refrigerating plant; Adam Schantz, Daytona, Fla., 1 complete 20-ton ice making plant to replace plant recently destroyed by fire; Westerlin & Campbell Co., Chicago, Ill., 1-90 ton and 1 40-ton refrigerating machine to be installed in the plant of the Northern Cold Storage & Warehouse Co., Duluth, Minn.; Sun Grocery Co., Auburn, N. Y., 10-ton refrigerating plant; Eagle Brewing Co., Utica, N. Y., 1 40-ton compression side; Celluloid Co., Newark, N. J., 2 30-ton

compression sides and water cooling plant; State Homeopathic Hospital, Allentown, Pa., 1 20-ton refrigerating and 10-ton ice making plant; Ohio Dairy Co., Toledo, Ohio, 1 10-ton refrigerating plant to be installed in their plant at Morenci, Mich.; S. B. Charters, Pittsburg, Pa., 20-ton refrigerating plant to be installed in their stores.

RECENT SALES REPORTED by the Ohio Blower Co., Cleveland, Ohio, of its Swartwout steam specialties include 2 10-in. and 1 5-in. vertical, high-pressure steam separators, 1 12-in. horizontal steam separator and 1 16-in. cast-iron exhaust head to Corrigan & McKinney & Co., Charlotte, N. Y.; 3 10-in. angle type separators to Sloss-Sheffield Steel & Iron Co., Florence, Ala.; 1 10-in. oil separator to the Peerless Motor Car Co., Cleveland, Ohio; 1 10-in. oil and an 8-in steam separator to John A. Reitz & Co., Evansville, Ind.; 2 7-in. vertical steam separators to South Covington & Cincinnati St. Railway Co. Various sizes of steam separators were furnished to Price Pump Co., San Francisco, Cal.; The Isaac Leisy Brewing Co., Cleveland, Ohio; The National Coal Co., Byesville, O.; Sholl Brothers, S. Bartonville, Ill.; Sanitary Plumbing & Heating Co., Fitzgerald, Ga.; Wolf Run Coal Co., Bergholz, Ohio; Wallace Stebbins & Sons, Baltimore, Md.; Hampton Co., Easthampton, Mass; St. Johns Military Academy, Dalafield, Wis.; Kile Mfg. Co., Akron, Ohio; and cast-iron exhaust heads to the following: Metropolitan Lt. & Power Co., San Francisco, Cal.; Central High School, Hammond, Ind.; Winona Hotel, Bay City, Mich.; Albion Paper Co., Holyoke, Mass.; Silverman & Co., Chicago, Ill.; James Curran Mfg. Co., New York City; The Leisy Brewing Co., Peoria, Ill.; Henry Vogt Machine Co., Louisville, Kentucky.

THE CHERRY CHEMICAL CO. which manufactures Red Seal boiler compounds, has occupied its new quarters for 6 months and reports good business. June was better than any June month for a number of years, showing that steam users have learned the value of the company's product. The office, of which Oliver Braden, who has been connected with the company for 15 years, is manager, is at 1018 Callowhill St., Philadelphia, where information about Red Seal compound may be had.

THE PITTSBURG STEEL SUPPLY CO., has recently been appointed agent for the Pittsburg district representing The American Steam Gauge & Valve Mfg. Co. The officers of the Pittsburg Steel Supply Co. are all experienced men and have a thorough knowledge of the requirements of the manufacturing concerns throughout greater Pittsburg.

OHIO BRASS COMPANY is sending out 2 folders, 1 describing its list of steam specialties, including the Collin gage cock, the Ohio water gage and gate valve, and Ohio bronze fittings; the other folder describing the Collin steam pressure regulating valve for all classes of service.

MESSRS. ADAM COOK'S SONS, 313 West Street, New York City, N. Y., makers of Albany Grease, recently received a letter from H. N. Saxton, Jr., president of the Knoxville Saw Mill Co., Ltd., Knoxville, Tenn., which tells of an interesting experience and points a remedy to lubrication troubles generally. "Friends of ours sometime ago had trouble with the bearings on the bottom shaft of a band resaw. They said they had tried everything that had been suggested, but still the bearing continued to heat. An expert was called in and said the shaft must have sprung. They took out their shaft and had it trued up, but the bearing still got hot until they asked our advice and we recommended Albany Grease, which they tried and have had no further trouble. We had the same experience sometime ago with the bearings on our band mill on account of the strain. The box kept burning out and we decided to try Albany Grease on this bearing and have had no further trouble. You cannot recommend it too strongly for the use on bearings in a band saw mill."


## WANTED

"Positions Wanted" advertisements not exceeding 50 words for subscribers to Practical Engineer will be inserted twice free of charge. "Help Wanted" and special advertisements 25 cents a line.

POSITION

As chief engineer. Experienced with steam engines and turbines. Best references as to character and ability. Address L. FitzSimmons, 162 Palmer St., Kokomo, Ind. 6-2

A PRACTICAL ENGINEER

Wishes to instruct engineers in the use of the slide rule by correspondence. Write for particulars. Address Geo. W. Richardson, 2181 W. 24th Place, Chicago. 6-2

PATENTS

Watson E. Coleman, Patent Attorney, Washington, D. C. Advice and books free. Highest references. Best services. 4 tf

WANTED

Engineers, Firemen, Electricians, Machinists, etc. New 25-page pamphlet containing questions asked by Examining Boards sent free upon request. Address, Geo. A. Zeller Book Co., 4467 W. Belle Place, St. Louis, Mo. Established 1870. 4 tf

WANTED

For first assistant engineer in a large state hospital. All-round electric and steam engineer who understands something of plumbing and steam fitting. Must be experienced. Position permanent for single man. Write for full particulars to C. F. Applegate, Mt. Pleasant, Iowa. 7-1

WANTED

Competent salesmen to handle metallic packing on commission in exclusive territory. Address, giving experience and references, Huhn, 1876 Broadway, New York City. 7-1

POSITION

Gas engineer is open for position. Ten years' experience on Westinghouse and Allis-Chalmers gas and steam engines. Past three years on gas engines exclusively. First class references furnished. Age 35. Address Box 81, Practical Engineer. 7-2

POSITION

Engineer and electrician wants position. Have had fifteen years' experience with engines, boilers and electrical equipment. Address F. N. Titus, 500 Monroe Ave., Rochester, N. Y. 7-2

ENGINEERS AND MECHANICS

to make big money selling Incomparable "Dozit" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Co., 225 Congress Street, Boston, Mass. 4 tf

FOR ENGINEERS

The new revised edition of the Modern Engineer's Hand Book. A $2.50 Book by mail on receipt of 50 cents. Be quick. Address, W. H. Ermentrout, 514 Elm Street, Reading, Pa. 4 tf

PATENTS

C. L. Parker, Late Examiner, U. S. Patent Office, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 Dietz Bldg. Washington, D. C. 4 tf

FOR SALE

60 steel storage tanks, 6,000 gallons' capacity. Good as new. Double riveted, extra well built. Suitable for storage of oils, waters or liquids of any kind. 100 steam pumps. Get our prices on engines, boilers and electrical machinery. All sizes and kinds. Chicago House Wrecking Co., 35th and Iron Sts., Chicago. 4 tf

SALESMAN

We want a good Salesman in every city in the United States, to handle Ideal Metallic Packing. Manufacturers' Agents and Engineers, preferred—Ideal Metallic Packing Co., South Stillwater, Minn. 4 tf